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Volume 2 — Number 7

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

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VOLUME 2 NUMBER 7

Models Predict Behavior of Falling Dam

Notable Tests on the Chute à Caron Obelisk Verify Cushioning Effect of Water

By ADOLPH J. ACKERMAN
ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, W. E. CALLAHAN CONSTRUCTION COMPANY, AND PETERSON, SHIRLEY, AND GUNTHER, MADDEN DAM, CANAL ZONE

THERE were no precedents to guide the engineers who toppled the huge Chute à Caron obelisk into the rushing Saguenay River in Canada in the summer of 1930. So successful was the feat that it looked simple—a characteristic of difficult tasks well done. But success was only the fruit of infinite pains. After the brilliant idea had been conceived, exhaustive tests had to be performed before the engineers of the Aluminum Company of America would undertake the work. In this paper, Mr. Ackerman, who was in charge of these tests, describes them graphically. The article by C. P. Dunn, M. Am. Soc. C.E., in the December 1930 issue, described the actual launching of the full-scale obelisk and gave a general picture of the project. The account that follows presents for the first time the important background of preliminaries, proving again that a project well planned is half completed. It rounds out the description of an exploit unique in engineering history.

WHEN the Chute à Caron "obelisk," an 11,000-ton concrete monolith built in a vertical position, was tipped into 22,000 sec-ft. of turbulent Saguenay River water, it created the largest artificial splash in history. This happened on July 23, 1930. Incidentally, the mass landed intact and settled to within one inch of its predicted position.

Through accounts in CIVIL ENGINEERING and elsewhere, American engineers are aware of the details of this unprecedented exploit. This is the first explanation, however, of the careful experiments that enabled such a successful result to be achieved. The layout of the work is shown in Fig. 1. The conditions that dictated the method adopted and its successful accomplishment were outlined in the December 1930 issue, by C. P. Dunn, M. Am. Soc. C.E. The general design, of the obelisk was established from a mathematical investigation which had been confirmed by three independent checks, but various practical problems remained either partly or completely unanswered. To what extent would the turbulent river carry the obelisk downstream before it would come to rest? How seriously would the monolith shatter when it struck the solid rock bed? Would a heavy padding be required on the face? Would the water act as a sufficient cushion for this huge block as it came hurtling into position? Would the obelisk tend to "skip" over the water, rebound, or in some other manner be deflected from its intended resting space? As the discharge of the river was controllable at the Ile Maligne Dam upstream, should the obelisk be tipped into a deep or shallow flow?

In seeking answers to these questions it was decided to build a model of the obelisk and river bed. The model required hydraulic, dynamic, and structural similitude. As far as is known this is the first time that such a combination of similarity conditions has been employed.

A part of the river bed, Fig. 1, was reproduced on a scale of 1:50 in a concrete flume of the Hydraulic Laboratory of the Carnegie Institute of Technology, Pittsburgh. The model river bed on which the obelisk fell was formed of concrete. The remaining area was of packed granulated slag to within one inch of suspended sheet-metal profile templates, and was surfaced with one inch of quick setting cement grout. This was finally painted with white cement for waterproofing and to provide a good photographic background. The model obelisks, Fig. 2, were made of concrete, cast in a permanent mold without reinforcing. Only part of the pedestal was constructed, the obelisk being held vertically by a string, which was cut to start the fall. Table I shows the various magnitudes applying to the prototype and model and the scale factors for proper similitude.

The investigation included six distinct steps, which will be taken up individually in their logical sequence. It should be noted that the magnitudes and dimensions applying to the model in most cases are given in terms of the full scale.

STEP 1—DETERMINING CORRECT STRENGTH OF CONCRETE

During the first stages of this investigation, the general opinion was that most of the energy of the fall and impact would be absorbed by the concrete in the obelisk. In fact, the design provided for a heavy network of reinforcing, and a layer of wooden poles or bales of hay on the face to cushion the fall. In Step 1 consideration was therefore given to the strength relations between the prototype and the model. These required the perfecting of a concrete material having an ultimate compressive strength of only 60 lb. per sq. in. and a modulus of elasticity as low as 80,000.

After the desired material had been developed by numerous trials, several obelisks were cast. Although the extreme weakness of the concrete made them difficult to handle, they were successfully tipped into the model

river without producing even a crack. However, when they were tipped into a dry channel, they were completely shattered. The clearly demonstrated cushioning effect of the water thus showed that the ability of the concrete to absorb the great energy of the impact was not of vital importance. The entire problem was one of hydraulics.

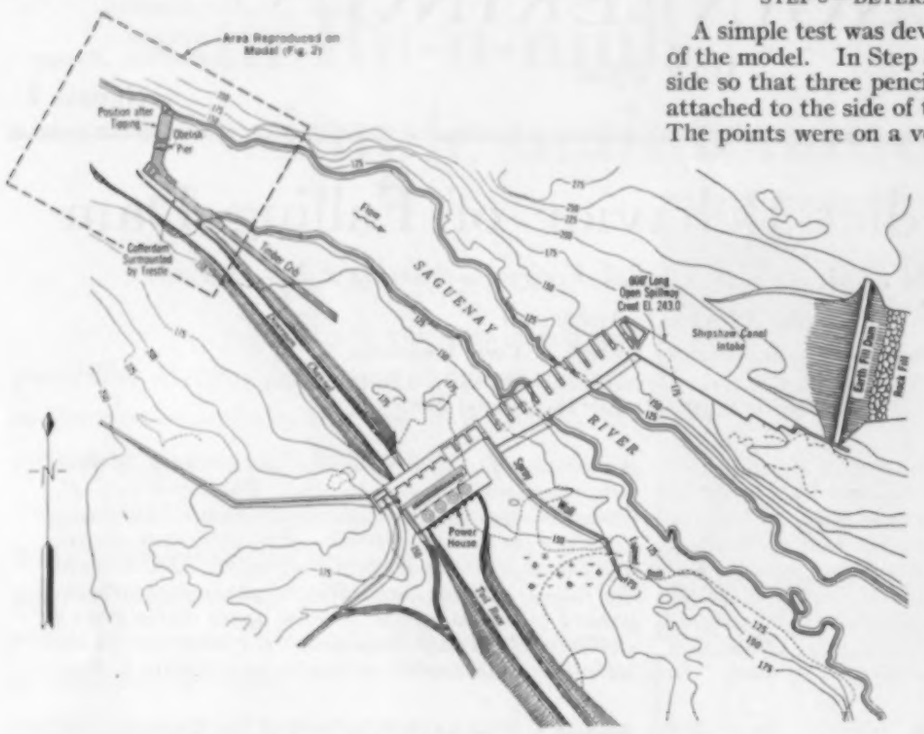


FIG. 1. GENERAL PLAN OF CHUTE À CARON DEVELOPMENT

STEP 2—DIRECT OBSERVATIONS ON THE FALLING MODEL

This discovery made it possible in Step 2 to study the cushioning effect of the water with a model of strong concrete capable of withstanding repeated dropping. This was tipped probably a hundred times under almost every conceivable condition—such as into various depths of water, into a dry channel, with and without loose rocks in the river bed, and with the obelisk placed initially in various skewed positions. Many of these tests were recorded in motion pictures, using a "slow motion" camera set to the proper time scale so that, when projected on a screen, they would give the effect of showing the fall of the prototype.

When no water was present, eccentric contact and serious rebounds always caused the obelisk to land in a variety of positions, none alike, and never in its intended place on the river bed. But when it was dropped into flowing water, the fall was highly satisfactory and the obelisk invariably came to rest in or near its patterned location, indicating a water cushioning effect with varying intensities of pressure, inversely proportional to the intervening space. During the process of deceleration, the obelisk would thus be deflected by the highly compressed water into areas of lower pressure and directed with surprising regularity into its natural seat, the only position where equalized pressures could be developed. The necessity of dropping the obelisk itself into a considerable depth of water was apparent.

STEP 3—DETERMINING THE PATH OF FALL

A simple test was devised to determine the path of fall of the model. In Step 3, a drawing board was set at one side so that three pencil points mounted on springs and attached to the side of the obelisk would record its path. The points were on a vertical axis, one directly over the center of gravity and the other two at the top and bottom. These experiments were performed in a dry channel and the results coincided accurately with the computed path of the center of gravity down to the point of initial contact with the river bed. At this point breaks were recorded, located in a straight line, which gave the angular position of the obelisk at the moment of striking.

In the original design of the obelisk, a basic assumption had been made—that better displacement of the water and some reduction in the horizontal component of velocity would be secured if the monolith entered the water at an angle and made its initial contact at the lower end. The results of the model tests fully supported this assumption. A study of the possible effect that an improper selection of the coefficient of base friction might have on the computed path of the obelisk was made by greasing the base and obtaining new recordings of the path. This gave a greater angle of inclination at the instant of striking the river bed, but introduced no objectionable effects.

TABLE I. DIMENSIONS AND SIMILITUDE FOR 1:50 SCALE MODEL

ITEM	PROTOTYPE		MODEL		
	SYMBOL	MAGNITUDE	SCALE FACTOR	MAGNITUDE	
				Computed	From Tests
OBELISK:					
Height	L_H	92.0 ft.	$L_H/50$	1.84 ft.	1.84 ft.
Width	L_W	45.0 ft.	$L_W/50$	0.90 ft.	0.90 ft.
Weight	W	22,630,000 lb.	$W/(50)^3$	181.3 lb.	179.4 lb.
Radius of gyration	K^2	749 (ft.)^2	$K^2/(50)^2$	0.30 (ft.)^2	.....
Moment of inertia	I	2,431,254 (ft.)^4	$I/(50)^4$	0.389 (ft.)^4	.....
Time of falling	T	6.0 sec.	$T/\sqrt{50}$	0.85 sec.	0.78 sec.
Maximum velocity of center of gravity	V_{CG}	60.2 ft. per sec.	$V_{CG}/\sqrt{50}$	8.50 ft. per sec.	8.30 ft. per sec.
Maximum velocity of top	V_T	82.5 ft. per sec.	$V_T/\sqrt{50}$	11.6 ft. per sec.	11.7 ft. per sec.
Maximum kinetic energy of center of gravity	K_E	1,274,000,000 ft-lb.	$K_E/(50)^4$	205.0 ft-lb.	192.0 ft-lb.
CONCRETE:					
Strength	F	3,100 lb. per sq. in.	$F/50$	62 lb. per sq. in.	64 lb. per sq. in.
Modulus of elasticity	E	4,000,000	$E/50$	80,000	Not measurable
Specific gravity	λ	2.40	1.00	2.40	.....
RIVER:					
Velocity	V_R	20 ft. per sec.	$V_R/\sqrt{50}$	2.85 ft. per sec.	.....
Discharge	Q	30,000 sec-ft.	$Q/(50)^{1/2}$	1.70 sec-ft.	1.70 sec-ft.
Kutter's friction coefficient of channels	N	0.035	..	0.019	.....
Specific gravity of water	ω	1.00	1.00	1.00	.....
Acceleration	g	32.2	1.00	32.2	.....

STEP 4—VELOCITY RECORDED GRAPHICALLY

The fourth step of the investigation was made up of a series of tests which accurately determined the velocity, acceleration, and instantaneous positions of the obelisk throughout its fall. The recording apparatus (Fig. 3) consisted essentially of a motor-driven drum, a speed-control rheostat, and a revolution counter. Above the drum three pencil carriages were supported on steel rods and connected by wires to short posts on the side of the obelisk at the same three points for which the path of fall had been previously determined. The wires were held under constant tension by a series of rubber bands, as illustrated.

To keep the length of wire displaced at the drum equal at all times to the length of path traversed, a grooved guide of the same shape as the path of fall was mounted adjacent to the obelisk, to support the wires during the fall. The recording system had no measurable influence on the free movement of the obelisk.

It was found that the final instant of fall was not shown correctly on the charts on account of the inertia of the pencil carriages. At first an attempt was made to modify the arrangement of rubber bands, but subsequent trials, by recording the deceleration of a hatchet driven into a block of wood, made it evident that such methods would have to be abandoned. The reliability of the data obtained from the drum recorder was therefore fully accepted for the first 95 per cent of the time of fall, but a new method for measuring deceleration had to be devised.

One of the most interesting charts developed from the drum records (Fig. 3) shows the angular movement of the obelisk. Taking for a given instant the recorded distance through which the center of gravity and the upper point had traveled, measuring these distances along their respective paths, and connecting the resulting points with a straight line extended down to the base, gave the position of the axis at that instant. As long as these axes converged on the rounded base, it is evident that the obelisk was rolling. At the instant of initial slip and subsequent plunging the axes diverged, and thereafter approached more parallel positions. The close relation between the theoretical computations and the data from the recorder is brought out strikingly in Fig. 3.

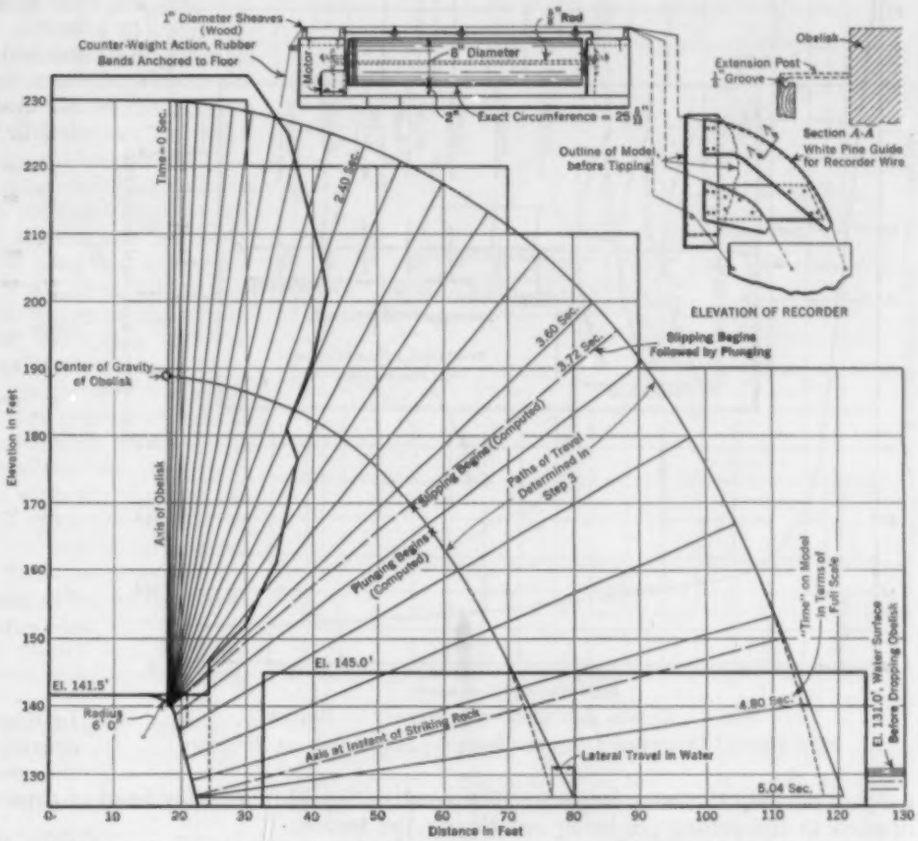


FIG. 3. DETAILS OF VELOCITY RECORDER AND ANGULAR POSITION OF FALLING OBELISK FOR EQUAL INTERVALS (0.24 SEC.)

FIG. 2. THE COMPLETED MODEL

STEP 5—TESTS TO MEASURE DECELERATION

In Step 5, tests were carried out to measure the decelerating effect of the water under various conditions of discharge and with various types of cushioning on the face of the obelisk. A cantilever spring supporting a weight and a flexibly mounted pencil point at its free end, was set on the model so that the weight traveled at the same maximum velocity as the top of the falling obelisk. At the instant of striking the river bed, the spring would deflect an amount proportional to the impact. Graphical records (Fig. 4) on cards mounted adjacent to the pencil point clearly showed how the water cushioned the obelisk.

By carefully weighing the parts and determining the static constant of the spring, it was at once possible to calculate mathematically, for a given recorded deflection, the energy absorbed by the spring or, in other words, the velocity of the weighted end of the spring at the instant of maximum impact. This was further reduced to the equation:

$$h = 9.46Z^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

in which Z is the recorded spring deflection in inches, and

h is the equivalent vertical drop of the top of the obelisk, or the height through which it would have to fall vertically to develop the same impact. The results (Fig. 4), applied to the prototype, bring out clearly the tremendous cushioning effect of the water.

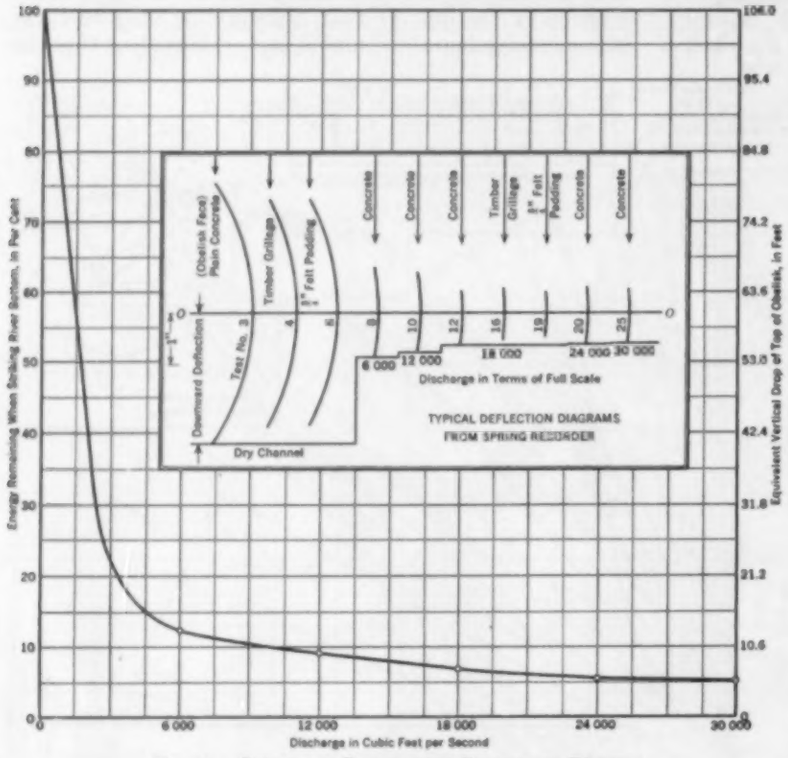


FIG. 4. CURVE OF CUSHIONING EFFECT OF WATER
With Typical Deflection Diagrams from the Spring Impact Recorder

STEP 6—DECELERATION OF BODIES FALLING INTO WATER

Although Step 5 had further demonstrated the great cushioning effect of water, the errors introduced by the crude instrument made advisable a sixth step, in an attempt to set up a mathematical expression to account reasonably for the observed conditions. For simplicity a cube with its base parallel to the floor was assumed to drop into a pool of water, assuming that during partial submergence the loss of energy depends on empirical factors, such as the viscosity of the fluid, the shape and density of the body, the angularity of the base, and the formation of eddies; and that after complete submergence the shape of the trailing side of the body will also affect the energy loss.

It seemed as infeasible to define such losses analytically as it is to evaluate theoretically the energy loss caused in a river by piers or other obstructions. Furthermore, if any experimental data existed, their extremely empirical nature would preclude their application to any but identical conditions. It was therefore assumed that, within limits corresponding to the present problem, a freely falling body on entering the water would continue at the same maximum velocity it had acquired in the air, and further, that acceleration due to gravity would be counterbalanced by buoyancy and hydraulic losses. This assumption was later proved to be fairly accurate; at the same time it greatly simplified the problem and was particularly justified in studies of final impact on the bottom.

As the body approached the bottom, there was a new phenomenon, an "orifice action" along the lower edges of the block as the final films of water were squeezed out under extremely high velocities. I have more or less arbitrarily assumed that this action begins when y equals one-half the shortest dimension of the base of the body. For this case, a reliable mathematical analysis was developed along lines first suggested by H. A. Thomas, M. Am. Soc. C.E. For this new hydraulic theory let:

D = linear dimension of cube
E = distance of free fall above water surface
F = head of water on bottom of pool
y = distance from base of falling body to bottom of pool
W = weight per cubic foot of water
M = weight per cubic foot of the body
v = vertical velocity of body in feet per second
$h' = \frac{v^2}{2g}$ = equivalent height of fall
u = lateral velocity of water under the body
g = acceleration due to gravity

The average displacement of water and of the cube during a short interval of time is:

$$vD^2 = 4Dyu \quad \ldots\ldots\ldots\ldots\ldots [2]$$

In descending a distance dy, the energy contributed to the water is equal to the weight displaced multiplied by its velocity head of dispersion, or

$$\text{Kinetic energy} = W D^2 dy \frac{u^2}{2g} \quad \ldots\ldots [3]$$

Equating the work done in retarding the cube in its travel through the distance dy, and the kinetic energy contributed to the water, as computed from Equations 2 and 3, and integrating:

$$\log_{10} \frac{E}{h'} = \frac{D W}{36.8M} \left(\frac{1}{y} - \frac{1}{F} \right) \quad \ldots\ldots [4]$$

In this formula, various values of y may be assumed, and the calculated magnitude of h', or its equivalent v, defines the velocity of the cube until it comes to rest on

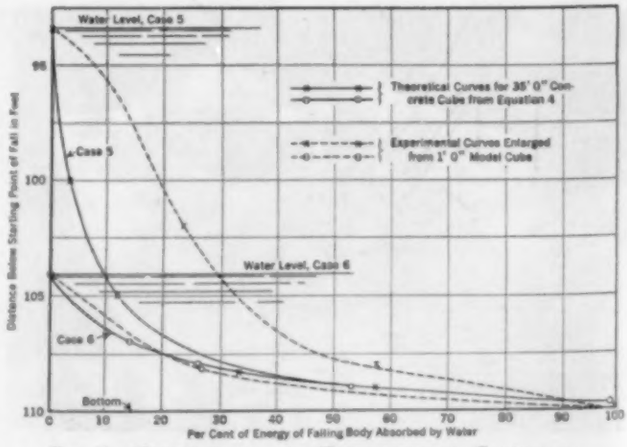

Water Level, Case 5
Theoretical Curves for 35' 0" Concrete Cube from Equation 4
Experimental Curves Enlarged from 1' 0" Model Cube
Case 5
Water Level, Case 6
Case 6
Bottom
Distance Below Starting Point of Fall in Feet
Per Cent of Energy of Falling Body Absorbed by Water

FIG. 5. THEORETICAL AND EXPERIMENTAL CURVES OF CUSHIONING POWER OF WATER

the bottom. Going a step further and applying these calculated velocities in Equation 2, the lateral velocity, u, of the water as it is squeezed out by the descending body may be determined at any instant.

Data from Equation 4, plotted in Fig. 5, show that the theory agrees with the conclusions obtained in Step 5—that practically all the energy of a falling block is absorbed by the water. The theory furthermore indicates that the depth of water has very little effect upon the deceleration, and that most of the work on the body is done as the final layer of water is squeezed out with what amounts to orifice action along its lower edge.

As an experimental check, the drum recorder used in Step 4 was set up on end over a concrete lined sump, Fig. 6. Cubical, cylindrical, and rectangular blocks in turn were connected to the pipe which extended to the recorder. The top of the pipe supported a suitable pencil carriage, designed to prevent the recording of any lost motion. As a further check, the spring recorder used in Step 5 was also mounted on the pipe.

A typical set of graphical data, combined on a single chart (Fig. 6), proves conclusively that practically all the deceleration occurs in the last instant of travel. The fillets at the lower ends of the curves are very pronounced, and their slopes coincide with the slope of the curve at the first inch of travel, thus again demonstrating that a body is decelerated between about 95 and 98 per cent before it touches bottom. Some of these results have been stepped up to apply to the same sized cube as was considered in plotting Fig. 5. Their curves bring out the close agreement between theory and tests for conditions corresponding to those surrounding the Chute à Caron obelisk.

It was also found that the spring recorder was energized into a greater deflection on striking the final layer of water under the cube than on striking the bottom, and that the conclusions from Step 5 were not only correct but conservative.

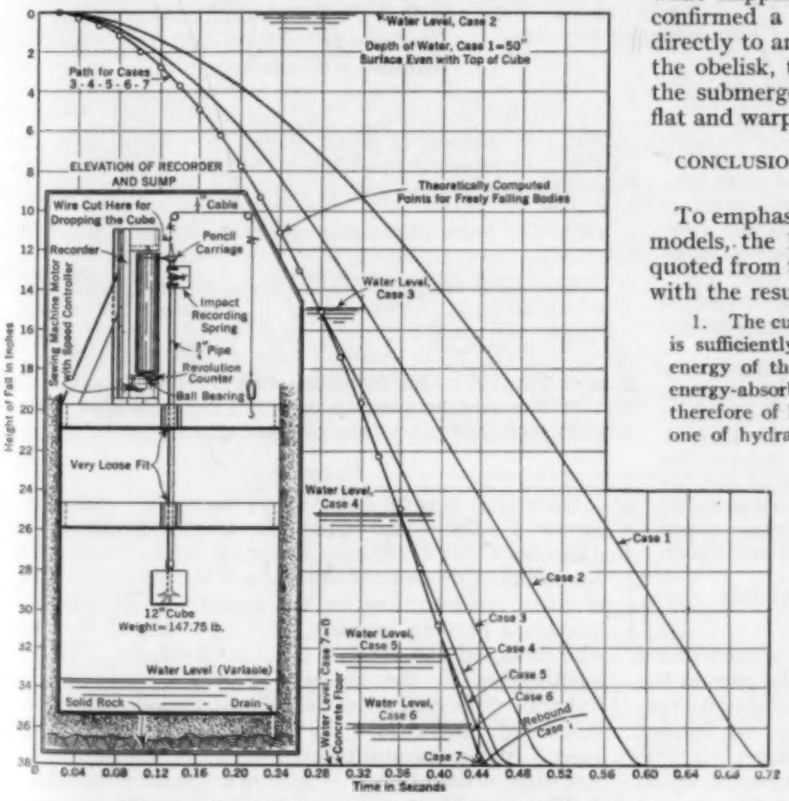


FIG. 6. APPARATUS FOR MAKING RETARDATION TESTS ON A CUBE FALLING INTO WATER
With the Records Obtained

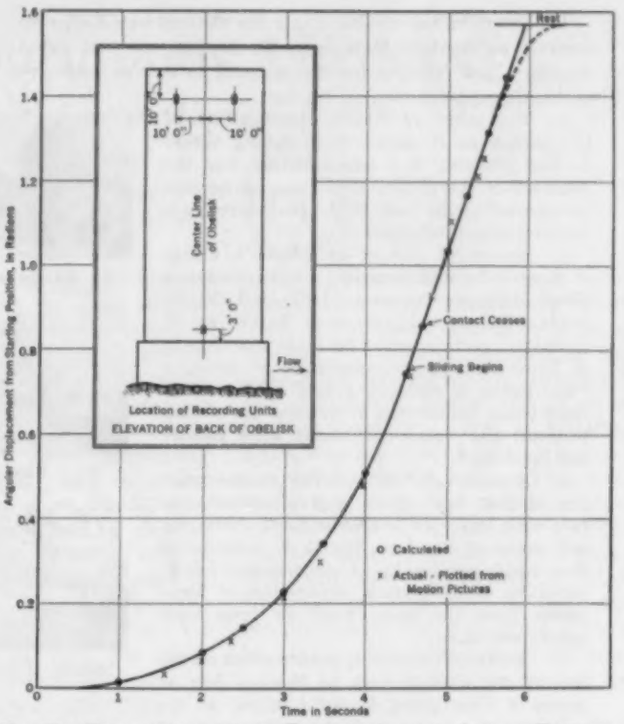


FIG. 7. COMPARISON OF THE CALCULATED AND ACTUAL FALL OF THE OBELISK

This series of tests provided an accurate picture of what happens when a body falls into water and also confirmed a theoretical analysis which can be applied directly to any body under conditions similar to those of the obelisk, the bottom face of which was parallel with the submerged surface on which it fell, including both flat and warped surfaces.

CONCLUSIONS FROM MODEL STUDY AND RECOMMENDED PROCEDURE

To emphasize the great value of experimental work on models, the 11 conclusions obtained from this work are quoted from the report on the model tests for comparison with the results obtained later from the prototype:

1. The cushioning power of the water in the river channel is sufficiently great to absorb at least 90 per cent of the energy of the falling obelisk before it strikes bottom. The energy-absorbing capacity of the concrete in the obelisk is therefore of lesser importance, and the problem is primarily one of hydraulics rather than structural dynamics.

2. The present design of the obelisk and its base is highly satisfactory. The top elevation and radius of rolling surface of the pedestal are well chosen, as is its location with respect to the river channel to provide for a definite amount of eccentricity, which is to compensate for the horizontal component of velocity of the obelisk.

3. The water will be thrown free from the upstream face of the obelisk, so that no force exists which may tend to move the obelisk downstream before it comes to rest. The outward rush of water will also sweep out any rocks or debris which may be resting on the river bed at the moment of tipping the obelisk. Any uneven initial striking of the lower end of the obelisk will be ineffective in seriously twisting the obelisk out of its axis during its remaining travel.

4. Dropping the obelisk into a dry channel would offer an entirely different problem from the present one and would require a new location for the pedestal as well as extensive cushioning construction on the face.

5. The effect of friction on the base of the obelisk as it passes from rolling action to free plunging is a minor feature, and the selection of the proper coefficient of friction in calculating the path of the obelisk requires no exceptional judgment.

6. Successful closure at Chute à Caron is assured by dropping the obelisk into any river discharge between 10,000 and 30,000 sec-ft. Between 15,000 and 20,000 sec-ft. discharge, corresponding to maximum depths of 20 to 24 ft., is recommended as giving a high degree of cushioning and at the same time being insufficient to overtop the obelisk pedestal and other cofferdams after closure has been made.

7. Because of the inability to construct the obelisk face so as to give uniform contact with the river bed, some local shattering will occur on the face, but it is improbable that major opening up of construction joints, extensive disintegration, separation of large pieces from the main body, or even large cracks will occur.

8. Artificial cushioning construction on the face of the obelisk, such as bales of hay or layers of wood poles is not justified in the presence of a water cushion; furthermore, it appears impracticable to attach it firmly enough to resist the high velocities of water which occur just before the obelisk strikes the bottom. The good bottom seal which bales of hay would provide can be obtained at less cost after the obelisk is down, by dumping rock, gravel, and sand on the upstream side. The presence of the forms on the face may be slightly beneficial in creating greater resistance for the escaping water and will at least save the cost of stripping, under extreme hazards, a large amount of form work which has no salvage value.

Ready to Be Tipped

After Firing Tipping Blast

Splash—Forms Thrown in Air

In Its Final Position

FOUR VIEWS OF THE CHUTE À CARON OBELISK FROM MOTION PICTURES

9. It is impossible to make a reliable estimate of the maximum stresses which may be developed in the obelisk, but present indications are that the experiences to be gained from the prototype obelisk will lead to more economical future designs with smaller widths and end clearances and great savings in reinforcing. However, the pioneering design of the present structure is fully justified.

10. The best attention and skill must be applied in the loading and blasting away of the supporting pier under the obelisk.

11. The obelisk as a device for cofferdamming a river appears to have excellent possibilities for future application, not only in the use of a single unit, but also in stepping a series of several obelisks across a river. The advantage of being able to design an obelisk to withstand over-topping from high floods and to estimate its cost in advance with fair accuracy should serve greatly to reduce the element of hazard which in other methods of cofferdamming has always required a high contingency reserve against loss of time and money.

PREPARATIONS FOR MAKING OBSERVATIONS ON PROTOTYPE

The general features of the spring impact recorder used on the model were readily adapted to similar use on the prototype, the springs being carefully calibrated from equivalent static tests. From the tests, an impact equivalent to a 5-ft. fall had been predicted. To be conservative, the springs were selected to record up to 15 ft. of equivalent fall, corresponding to 90 per cent water cushioning. A phonograph needle scribed the deflections on smoked glass. The units (Fig. 7) were covered with steel-plate housing to protect them from splashing water.

A large target was mounted over the center of gravity of the obelisk and various motion picture cameras were set up to record the fall, including a slow motion camera. One camera was set at right angles to the line of fall; the target was in full view and also, at one side, a seconds pendulum with a graduated scale. Later the individual pictures of the film were projected on a screen and the photographed simultaneous positions of the obelisk and pendulum at various intervals were plotted on this screen.

RESULTS OBTAINED FROM PROTOTYPE

The monolith was tipped into the river while it was discharging 22,000 sec-ft. and had a maximum depth of 25 ft. Except for some small hair cracks and a slight opening of a construction joint to about 1/32 in., no breakage was found. It was estimated that the out-rushing water under the obelisk acquired a maximum velocity exceeding 200 ft. per sec.

In Table II, showing the recorded impact, the "per cent cushioning" is a ratio between the "recorded equivalent height of fall" and the "calculated equivalent height of fall at the instant of maximum velocity," the latter being about 106 ft. for the top of the obelisk. This tremendous cushioning ability gives further support to the theoretical deductions. The obelisk landed laterally within 1 in. of its predicted position. Its back was out of level 3.22 ft. in a diagonal distance of 102 ft.

These results showed that the soundings were exceptionally accurate. The indications are, however, that the cushioning effect would have been high even with greater errors in soundings as long as the face of the obelisk was of such size as to require a long distance of lateral travel for the displaced water. The data obtained from the motion picture records (Fig. 7) show the remarkable accuracy of the original calculation.

TABLE II. DATA ON THE FALL SECURED BY IMPACT RECORDERS

LOCATION ON OBELISK	RECORDER DEFLECTION	RECORDED EQUIVALENT HEIGHT OF FALL	PER CENT CUSHIONING
Top left	0.43 in.	2.44 in.	99.80
Top right	0.42 in.	1.8 in.	99.86
Bottom center	0.30 in.	0.92 in.	99.93

PERSONNEL

Under the general direction of James W. Rickey and James P. Growdon, Chief Hydraulic Engineer and Assistant Chief Hydraulic Engineer, respectively, of the Aluminum Company of America, I was in direct charge of these investigations on the model and prototype for the Alcoa Power Company, Ltd., of which C. P. Dunn, who designed the obelisk, is Chief Engineer. All have membership in the Society. I. G. Calderwood was General Superintendent of Construction, with Ross White, M. Am. Soc. C.E., Acting Superintendent, and Joseph Black, Assistant Superintendent, during the construction of the obelisk. Acknowledgment is due Harold A. Thomas, M. Am. Soc. C.E., head of the hydraulics department of the Carnegie Institute of Technology, Pittsburgh, for his generous cooperation.

Bridges with Continuous Girders

Reviewing Half a Century of Experience in American Practice

By Gustav Lindenthal

Honorary Member American Society of Civil Engineers
Consulting Engineer, Jersey City, N.J.

BRIDGE engineering for the modern age is advancing in great strides. Each year sees new accomplishments—longer spans, heavier loads, greater capacity—and the end is not in sight. As regards types of span, progress is also apparent. From his experience of over half a century, Mr. Lindenthal gives a few high lights illustrating this progress as shown by the development of the continuous bridge. This account carries him from Pittsburgh bridges built in the eighties to modern spans in the Far West, at Portland, Ore. Striking similarities will be apparent between the present-day structures and the older examples. As a readable commentary by a leading authority in this field, Mr. Lindenthal's interesting observations will command the attention of all engineers.

RECENT increased interest in continuous bridges is an encouraging development, as it tends to restore to proper importance a type of construction that has been somewhat overlooked by many engineers in past years. Some of the more unusual, and hence less familiar, forms of this type of bridge will serve to illustrate its possibilities.

The history of continuous girders goes much farther back in Europe than in America. Wrought-iron bridges and viaducts with multiple spans of this type were built for railroads over rivers and deep valleys in Germany, France, Switzerland, and Austria as far back as about 1835. The pioneer conditions under which railroads were built in America, commencing about 1840, made it necessary for metal bridges to be manufactured at bridge shops in a form suitable for long-distance transportation so as to reduce field work and facilitate erection. Therefore the simple girder with long panels was preferred.

FIRST AMERICAN DEVELOPMENTS

At that time the objection of American bridge engineers to continuous girders was further increased by their prejudice against reversional stresses in wrought iron and later in steel, as shown by bridge specifications up to fifteen years ago. In the absence of sufficient tests, over-cautious bridge engineers went so far as to declare that continuous girder bridges were dangerous and un-American. This prejudice was not shared by some able engineers, such as James B. Eads and Henry Flad, both Members of the Society during their lifetime, who together built the arch bridge at St. Louis in 1874, or by C. Shaler Smith, also a Member, who designed and built in 1894 the first continuous girder bridge in this country for the east approach to the Eads Bridge in St. Louis. Tension and compression of great amplitude alternate in the main members of these bridges. C. Shaler Smith also designed and erected without falsework the continuous girder bridge over the St. Lawrence River at Lachine Falls, which was replaced by heavier simple girders in 1910. This versatile engineer also designed and erected without falsework in 1874 the first cantilever railroad bridge in this country—the Kentucky High Bridge. In 1898 this bridge was rebuilt under my direction with a higher, double-track structure consisting of simple girders erected by the cantilever method.

Continuous girders with small lattice webs remained in vogue in Europe up to thirty years ago. It was my good fortune at the beginning of my career, about 1873, to get valuable experience in this kind of work on the engineering staff for the railroad viaduct at Ossingen, over the River Thur in Switzerland. In its day this was quite an important structure, made up of five spans of a total length of 1,000 ft. on iron towers 100 ft. high. The spans were erected with a camber of 3 ft. After the trusses were riveted, they were let down on the iron tower bearings. It was computed that the reversional stresses due to temperature and live load would nullify the initial stresses of erection and increase the rigidity of the bridge.

Since those early times, the weight of locomotives and cars has increased considerably. As a rule continuous girder bridges stand up better under the greater loads than the early simple truss bridges, many of which suffered from excess vibration and were replaced by heavier structures.

EARLY TYPES WITH CONTROLLED PIER MOMENTS

Experiments using the funicular principle for continuous girders were made by me over forty years ago

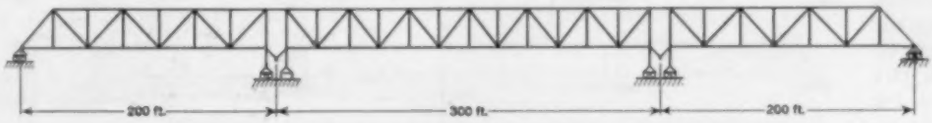


FIG. 1. HERRS ISLAND BRIDGE, BUILT IN 1883
Continuous Highway Span Over the Allegheny River Near Pittsburgh

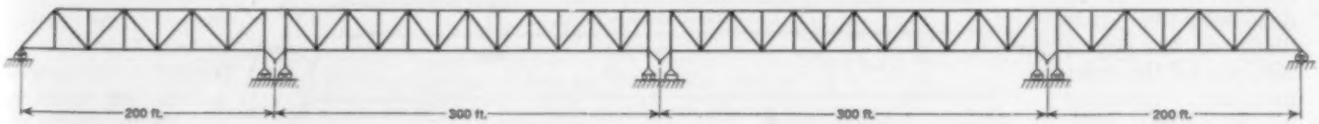


FIG. 2. MCKEESPORT BRIDGE, BUILT IN 1890
Providing a Roadway and Two Trolley Tracks Over the Monongahela River

for two highway bridges near Pittsburgh, Pa. One of these was the Herrs Island Bridge built in 1883 over the Allegheny River, with its three through spans—of 200, 300, and 200 ft., respectively—shown in Fig. 1. The other bridge, built in 1890 over the Monongahela River at McKeesport, carried a roadway and two trolley tracks on four through spans—200, 300, 300, and 200 ft., respectively—as shown in Fig. 2. Within the last ten years these two bridges have been replaced by higher and heavier structures.

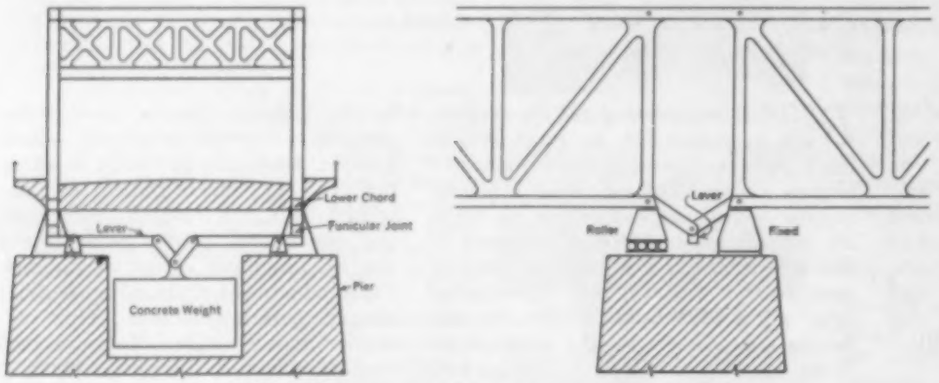


FIG. 3. DIAGRAM OF THE ARRANGEMENT AT THE PIERS
Herrs Island and McKeespo.t Bridges

In the case of both the original bridges, the danger from sudden high floods and the demands of navigation required erection of the middle spans without falsework. The pier foundations in both instances were wooden cribs bedded in deep gravel. They were safe, but not free from probable settlement. For this reason the usual continuous girder appeared too risky and the alternative of cantilever trusses was more expensive. I therefore made designs in both cases for continuous girders in which the stresses were statically determinable, effecting a considerable saving in metal and cost over simple girders. The spans were erected across the river channels by cantilevering without falsework.

Between the ends of the bottom chords on the piers was inserted a funicular device subject to upward pressure from a weight lever under the floor, as shown in Fig. 3. The weight on the longer arm of the lever was a concrete block suspended out of sight in a well in the middle of the pier. The upward pressure at the apex of the funicular detail was chosen to produce an end moment in the trusses over the pier to balance the dead load of half the middle span. Therefore the bending moment at the center of the truss was zero for dead load and maximum for live load. The algebraic sum of the stresses from dead and live loads dictated the cross sections for the truss members, resulting in a saving over single girders of more than 10 per cent of metal. The funicular detail was so devised that in case the pier settled, the upward pressure could be regulated by adding to or subtracting from the concrete weight. The stresses in the trusses were therefore under perfect control. Both bridges were notably rigid under moving loads.

Notwithstanding the economy and perfect practicability of this funicular device, even for heavy railroad structures, I did not use it in other bridges, preferring the orthodox continuous girder because of possible neglect of maintenance of the movable parts by careless inspectors. This may be no longer a well founded objection in view of the successful experience with counterweight devices in lift bridges. Later on, when sufficiently powerful hydraulic jacks became available for lifting heavy trusses, the risk from yielding pier foundations disappeared. It is a simple matter to design the bearings of continuous trusses so that hydraulic jacks can be inserted to lift or lower them to their original true levels.

VARIOUS DEVICES FOR CONTINUITY

In 1883, while studying the funicular principle for continuous trusses, I examined several other variations, shown in Fig. 4, Types A through F. The characteristics and shortcomings of these types may be listed as follows:

Type A. Three simple spans, with pin-connected eye-bars for all tension members. The falsework required for erection is objectionable to navigation.

Type B. Continuous girders; stresses analyzed by the theorem of three moments; channel span erected without falsework. This type is objectionable because of possible settlement of the piers.

Type C. Continuous girders with determinate pier reactions and indeterminate bending stresses in the girders; channel span erected without falsework. This type is also objectionable because of possible settlement of piers.

Type D. Continuous girders, with determinate stresses, and top chords connected over the pier by weight. The objectionable thing about this type is its unsightliness.

Type E. Continuous girder with funicular device between the bottom chords, the apex resting on the pier; and the channel span erected without falsework. The objections to this type are the extra material required for erection and the impossibility of regulating the links after settlement.

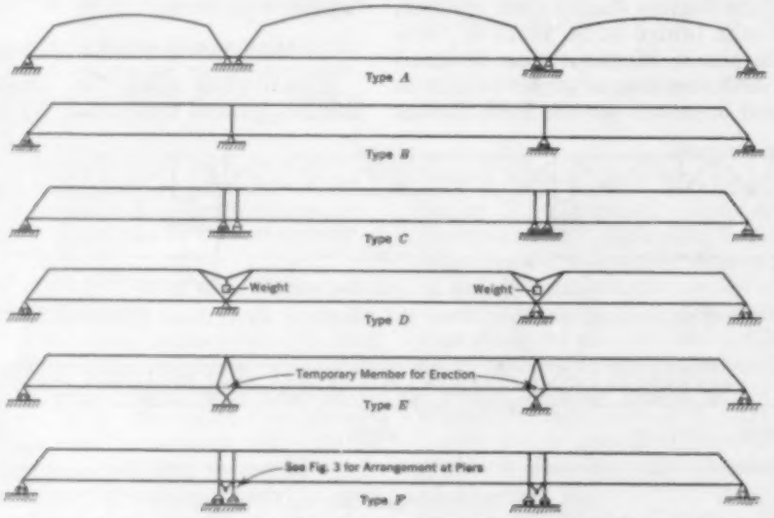


FIG. 4. A DEVELOPMENT OF CONTINUOUS GIRDERS WITH FIXED PIER MOMENT

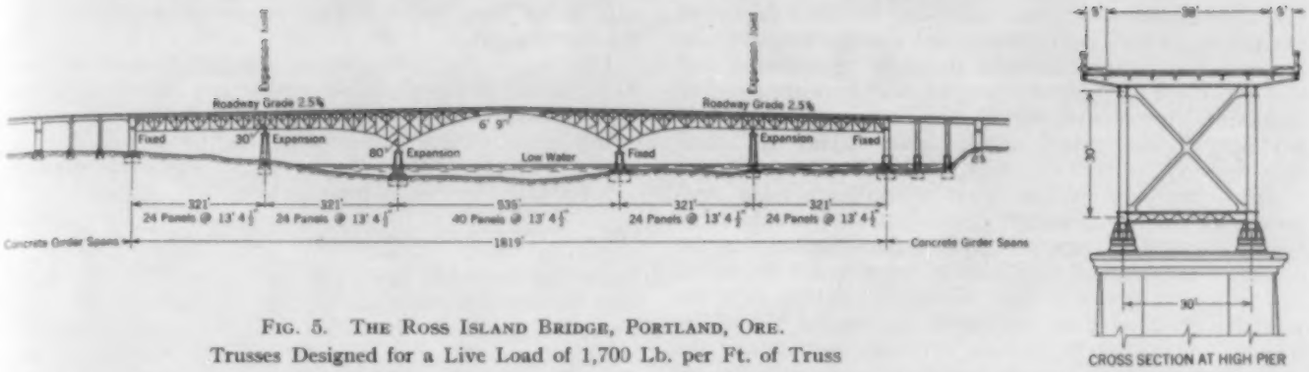


FIG. 5. THE ROSS ISLAND BRIDGE, PORTLAND, ORE.
Trusses Designed for a Live Load of 1,700 Lb. per Ft. of Truss

Type F. Continuous girder with weighted funicular links between bottom chords; channel span erected without falsework and without extra material. In case of settlement the stresses can be easily regulated by increasing or decreasing the counterweight, which is out of sight below the floor.

The obvious type, Fig. 4 *D*, would have been quite effective, for instance in the Sciotoville Bridge with its two continuous spans; but the large concrete blocks between the end posts would have been unsightly. The reverse arrangement, Fig. 4 *E*, in which the apex of the funicular device rests on a single bearing on the pier, is likewise statically determinate; but because of certain objections which I had to this arrangement at the time, this system was not further developed then. It is fortunate for the art of bridge designing that Ernst M. Wichert, of Pittsburgh, did so, and I gladly give him credit for adapting this valuable principle to the design of continuous girders and bringing it into use. If necessary, its advantages can be combined with adjustable bearings on piers, which make it safe and economical also over alluvial rivers where pier foundations are sometimes liable to considerable settlement.

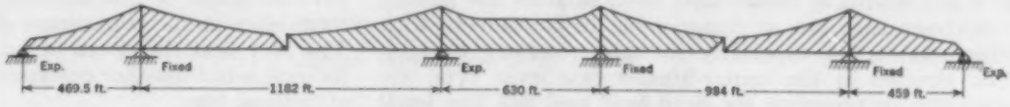


FIG. 6. THE QUEENSBORO BRIDGE, NEW YORK
A Continuous Girder with Expansion Joints

MORE RECENT ADAPTATIONS

It is plain that the "Wichert" system, which is patented, is also applicable to continuous girders with an expansion joint in the center, as in the cantilevers of the Queensboro Bridge, and that it is decidedly preferable to the cantilever system with the usual suspended spans, which may henceforth be considered obsolete. Yet in certain cases the fixed pier moment, system Fig. 4 *F*, as used on the Herrs Island and McKeesport bridges, would be preferable. Such a case may arise in a suspension bridge combined with stiffening trusses, continuous through the towers. With controlled, fixed bending moments at the towers, the bending stresses due to varying temperature from the rising and falling cables would be practically eliminated in low trusses and greatly reduced in high ones.

In the December 1931 issue of PROCEEDINGS. Charles M. Spofford, M. Am. Soc. C.E., described the Lake Champlain Bridge, which has continuous girders for the main spans. A similar structure, the Ross Island Bridge, having arched continuous girders, was built under my supervision in 1925–1927 over the Willamette River in the city of Portland, Ore., for the county government. There I also supervised the erection of the Sellwood Bridge, which has continuous parallel chord girders.

The economy and greater stiffness of continuous girders of one or the other kind are of special significance in combination with the alloy steels now frequently used, which permit higher unit stresses but produce greater deflections. It is the distinctive merit of continuous girders that, in addition to their economy, they have smaller deflections than simple girders.

EXAMPLE OF ROSS ISLAND BRIDGE

The disposition, length, and cross section of the spans of the Ross Island Bridge are shown in Fig. 5. The bridge has a central arched span of 535 ft. and two flanking spans of 321 ft., forming continuous girders.

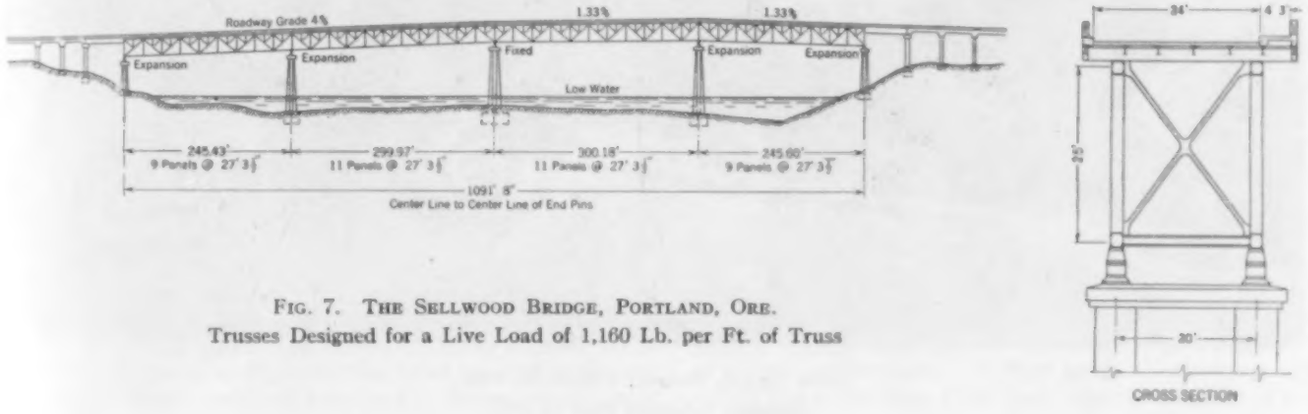


FIG. 7. THE SELLWOOD BRIDGE, PORTLAND, ORE.
Trusses Designed for a Live Load of 1,160 Lb. per Ft. of Truss

For the middle span it was necessary to avoid falsework because it would have obstructed navigation and also because the river is subject to scouring currents and sudden rises. To secure a pleasing appearance and economy, the superstructure was arranged as a deck bridge with an arched middle span having the clear height over the river required by the War Department.

Fixed bearings on high piers would have been preferable for the long middle span, but they would have required cantilever arms with an expansion hinge in the center. This system was used in the through trusses of the two river spans of the Queensboro Bridge over the East River, New York, in which the central hinges are formed of braced pendulum eye-bars connecting the end of the top chord of one cantilever arm with the end of the bottom chord of the other arm (Fig. 6), and transmitting the shearing stresses of alternate tension and compression.

NO CENTER HINGE USED

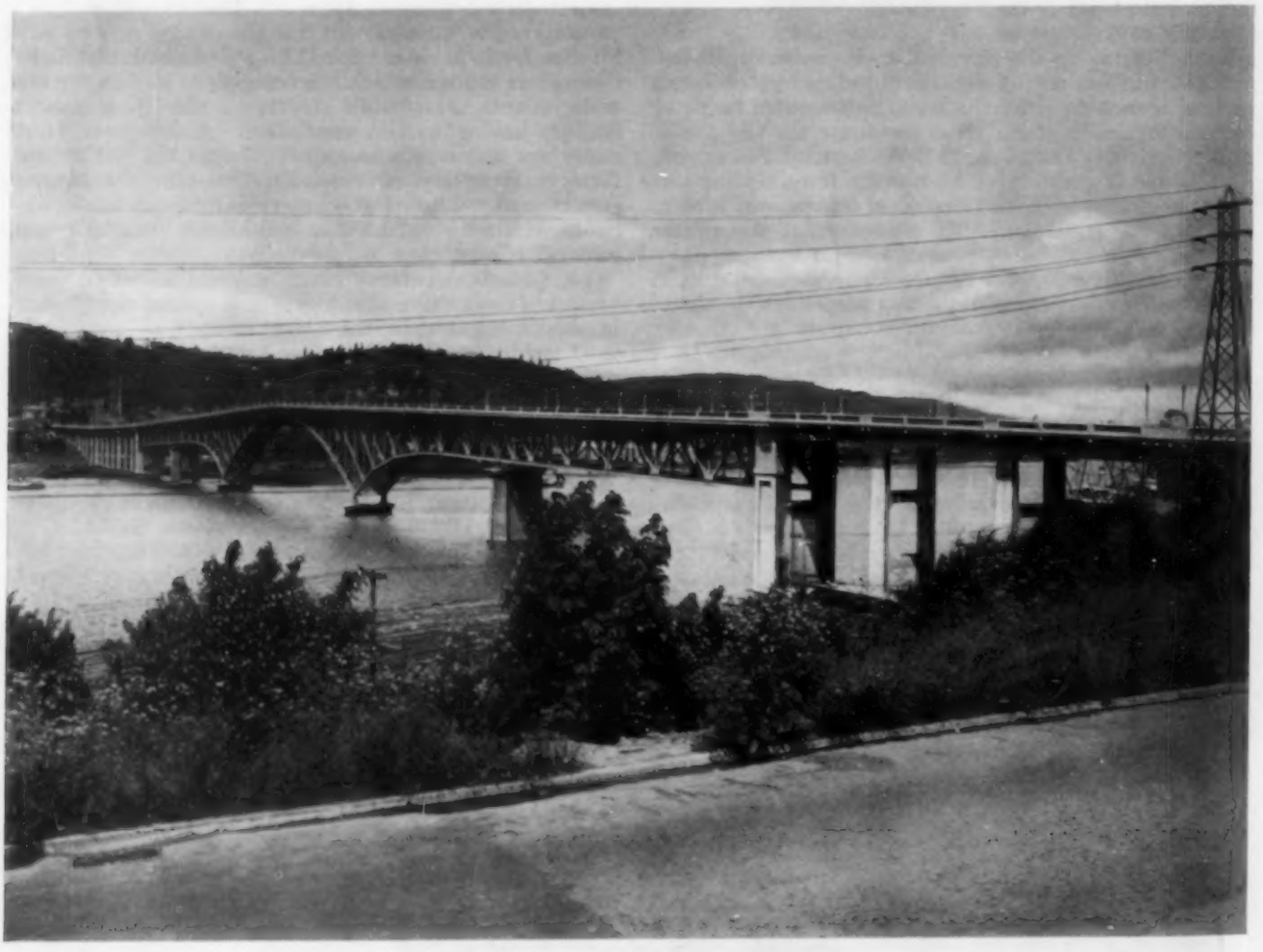
Deflection due to moving load causes a reversal in the bending stresses near the hinge. This is a good feature in that it prevents the deflections from becoming cumulative and results in remarkable freedom from the jerking vibrations that are so disagreeable in cantilevers with suspended arms, especially in light roadway bridges. The stresses in the center-hinged cantilever type are statically determinate for dead load and full live load; only those from moving load require computation by the elastic theory.

The use of the center hinge was not feasible in the Ross Island Bridge because of the low depth of truss at the center; and a sliding detail appeared objectionable owing to its tendency to become worn and loose after a time. Therefore the cantilever arms were rigidly connected to form a continuous girder.

ANOTHER CONTINUOUS TRUSS

For the Sellwood Bridge of four spans (Fig. 7), economy likewise indicated the placing of roadway and sidewalks on a deck structure. The necessary clearance height above the river limited the height of the trusses, which were made continuous to obtain greater rigidity and make possible the erection of the middle spans without falsework. The arrangement proved quite satisfactory. The bridge is unusually rigid and, like the Ross Island Bridge, has the further advantage that the solid concrete roadbed on top acts as a roof, protecting the steelwork underneath so that it requires less frequent painting.

These experiences, recounted very briefly here, have covered about a half century. During that time my confidence in the continuous girder has not diminished. The fact that this form of bridge is again coming into its own is but another evidence of its inherent value as a structural type.



ROSS ISLAND BRIDGE, PORTLAND, ORE.
Highway Structure Built in 1927

KAIGHN AVENUE TRAFFIC CIRCLE NEAR THE CENTRAL AIRPORT, CAMDEN, N.J.

Traffic Circles and Rotary Traffic

A Solution for the Problem of Congestion at Existing Multiple Street Intersections

By HERBERT S. SWAN

CITY PLANNER, NEW YORK, N. Y.

TWO methods of relieving traffic congestion at intersections have been developed—the traffic circle and the grade separation. Because of the large area required for traffic circles and their consequent cost, they had fallen out of favor until recently, when they were revived by the New Jersey State Highway Commission. In this article Mr. Swan points out the advantages of various sizes and shapes of traffic circles and outlines the conditions under which they are most effective. He believes that the traffic circle is the most efficient means of caring for traffic at multiple intersections, and that, generally speaking, it is less expensive than a grade separation.

EVERYWHERE the street intersection is the crux of the congestion problem; it controls both the flow and the volume of traffic along the whole highway. Heavy traffic necessitating alternate stop-and-go control frequently reduces the actual traffic capacity of each street at an intersection to less than one-half its potential unobstructed flow. Sometimes the interference due to turns and cross-traffic is so great that the efficiency of intersecting streets is reduced to 40 or even 30 per cent of their maximum capacity.

Could the obstructions encountered by traffic at such intersections be removed, the capacity of the highway would be increased as much as it would be by the provision of one or two new streets. Since this duplication of present highways is obviously impracticable, traffic barriers must be broken down by effecting every possible improvement at intersections. Only two methods have as yet been evolved to accomplish this result: (1) the introduction of traffic circles and rotary traffic at intersections, and (2) a separation in grades of the two roadways at the point of crossing. It is believed that the first of these methods has received in the past less attention than it deserves.

TRAFFIC CIRCLES NOT ALWAYS CIRCULAR

Traffic circles may be, and very often are, circular in form, but they are also of other shapes. Some are ovals and others are rectangles with rounded corners. The main consideration in the construction of a traffic "circle" is not so much its circular shape as the rotation of traffic around a pivotal area in distributing itself among several different highways.

It is all-important that streets entering a traffic circle should be spaced sufficiently far apart so that traffic has an opportunity to distribute itself. Where streets enter at points very near together, vehicles do not have time to spread out within the circle before they are overtaken by other vehicles from the rear. Then the traffic behind must halt until that in front has had time to distribute itself.

In determining the shape of a traffic circle, the angle formed by the intersecting streets is of vital consideration. If these streets intersect at very acute angles, the circle must be larger than if they intersect at right angles. For instance, if there are but two intersecting streets in the circle and they cross at a sharp angle, then the circle will probably not be a circle at all, but a parallelogram, lying lengthwise in the general direction of the acute angles formed by the intersecting streets. If, however, the cross streets intersect at right angles, then very likely it may be a true circle.

The radius of a traffic circle should be made such that the circular roadway, measured along its center line, will provide the minimum distance required by traffic to weave from one line to another between streets in entering and leaving the circle. In order that traffic from other parts of the circle should not be held back, this distance normally should be not less than 100 ft. The number of intersecting streets, the angle of intersection, the topography of the area affected by the intersection, the present and prospective volume of traffic on the entering streets, as well as the amount of traffic interchanged between these streets, are all factors that must be given proper weight in determining the size and shape of a traffic circle.

MULTIPLE INTERSECTIONS DEMAND CIRCLES

A multiple street intersection of five, six, or more streets usually constitutes a challenge that a separation of grades cannot meet. All the grade eliminations with which I am familiar affect only simple intersections of

two streets. To attempt a separation of grades at an intersection with numerous entering streets as a rule would involve so many bridges, underpasses, and ramps that the result would be grotesque. For instance, a 5-point intersection requires no less than 20 different movements of traffic; a 6-point intersection, 30 movements; a 7-point, 42 movements; and an 8-point, 56 movements. It is inconceivable from a practical standpoint that bridges and ramps could be developed efficiently to meet such conditions.

FIG. 1. KAIGHN AVENUE TRAFFIC CIRCLE, CAMDEN, N.J.

A multiple intersection practically demands a circle for a satisfactory handling of traffic. In Washington, D.C., for instance, Iowa Circle and Massachusetts Circle each care for 8 streets; Dupont Circle provides for 10; Stanton Square, for 12; and Lincoln Square, for 14. A circle, if well designed to serve its particular location, will bring all the conflicting vehicular streams from the intersecting streets into a single stream traveling in the same direction. Without interrupting the flow, it will distribute the traffic again into the various streets.

Of course the best practice in present-day street design frowns on the multiple street intersection. Today we attach less importance to what L'Enfant, in laying out Washington with its radials and circles, saw fit to term "reciprocity of sight," and more weight to simple intersections. Wherever possible, the number of streets at a given intersection is kept down to two. But the fact must not be ignored that there are a number of multiple intersections already in existence.

One of the problems of highway engineers is to keep traffic as liquid as possible at these complicated centers. The installation of "stop-and-go" control means mostly "stop" for the greater part of the traffic. At the Place de L'Etoile in Paris, with its 12 entering streets, alternate stop-and-go regulations would be obviously impossible. Under such a regulation, the capacity of entering streets would be reduced to not more than a very small percentage of their uninterrupted flow. With maximum traffic, vehicles on these streets would be held up for a longer period than they would be in motion. As it is, however, the Place constitutes an excellent traffic circle. It has a center roadway about 90 ft. wide, an inside radius of about 180 ft., and an over-all diameter of about 894 ft. Traffic moves around the Arc de Triomphe at a high speed, with scarcely any interruption whatever.

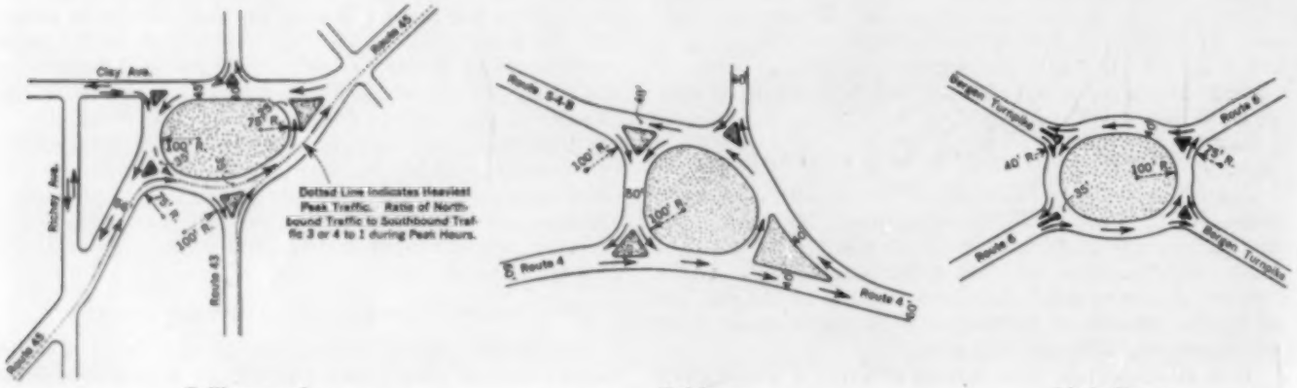
PEDESTRIANS AND TROLLEY CARS PRESENT PROBLEMS

In cities, the two main problems of the traffic circle are those of the pedestrian and the trolley. The pedestrian, of course, will nonchalantly "jay-walk" even though he be killed for it; there appears to be no effective way of stopping him. But even if he did not jay-walk, his presence in the circle would introduce a new element in the control of traffic. Such a circle, to be effective, presupposes continuously rotating traffic. The entrance of the pedestrian necessitates the introduction of stop-and-go control at every path set aside for his use. In other words, an attempt must be made to reconcile two mutually antagonistic and irreconcilable principles. Naturally, traffic cannot keep on rotating after the introduction of conflicting traffic movements.

Stop-and-go control must then be established at different points on the circle. But even with all this interruption, the application of the rotary principle probably will make it possible to handle a larger volume of traffic with less interference and delay than could be done under any other method of control at a multiple intersection. The capacity of a reasonably large traffic circle is so great that even after the installation of stop-and-go control for the protection of pedestrians, such a circle will still be able to care for its traffic load.

As a rule, trolleys are scarcely less embarrassing to rotary traffic than pedestrians. The usual reason for this is that trolleys decline to fall into the rotary movement. More often than not they are so routed that they cut across an intersection. Their path, instead of coinciding with one of the vehicular lanes in the circle, intercepts the lanes at right angles, if indeed it does not sometimes meet them squarely head on. Then, too, trolleys sometimes stop in the middle of a traffic circle to load and unload passengers. This complicates matters still more. Because of such objections as these, rotary traffic was abandoned a short time ago in Columbus Circle, New York, N.Y.

If the traffic circle is sufficiently large and is well designed, there appears to be no logical reason why the principle of rotary traffic cannot be applied as well to trolleys as to other traffic, provided all loading and unloading of passengers is done outside the circle. The suggestion has been made that trolleys, in passing through a traffic circle, should utilize the vehicular lane next the curb so that passengers can leave or board the cars without cutting across the traffic in the circle. This idea is good as far as it goes, but unless trolleys are to utilize the vehicular lane nearest the curb on all streets throughout the city, they cannot do so in the case of traffic circles without crossing the flow of traffic on half



Collingswood Fairlawn Little Ferry

FIG. 2. SOME TRAFFIC CIRCLES IN NEW JERSEY

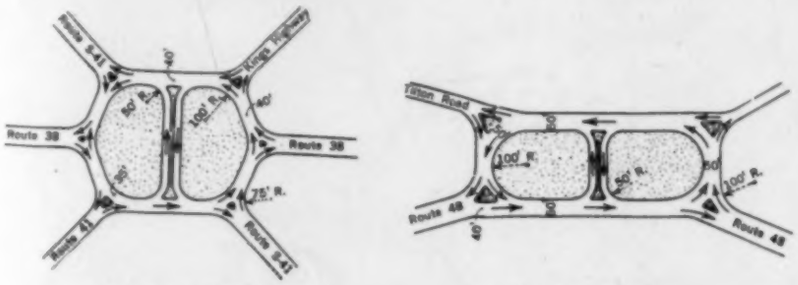
the roadway, both in entering and leaving intersections. Although these cross movements are in themselves undesirable, there may be many cases where they would be no more of an embarrassment to traffic than passengers crossing the roadway to board or leave trolleys in the center of the circle.

Even at best, trolleys are inflexible and unadaptable in their movement. They occupy a fixed path; they cannot deviate a single inch, irrespective of traffic conditions. This rigidity of movement is a distinct liability not only to themselves but also to all other traffic utilizing a common thoroughfare with them, whether it is a main highway, an ordinary street intersection, or a traffic circle. Unquestionably the interests of fast traffic are best served by the complete exclusion of trolleys from the traffic circle.

Satisfactory operation of such traffic circles as the one at Kaighn Avenue, Camden, shown in Fig. 1, is due in no small part to the complete absence of both pedestrians and trolleys. When the surrounding area is built up and the circle is invaded by a considerable number of pedestrians, no doubt there will be much less mobility in the traffic flow. Such an intrusion of pedestrians will also seriously lower the maximum capacity of the intersection.

CAPACITY AND DIMENSIONS OF CIRCLE

What shall be taken as the maximum uninterrupted flow of traffic per vehicular lane? On a straight roadway, where traffic moves at the rate of 40 miles an hour, a traffic lane should carry about 900 vehicles per hour. An intersection with four entering highways, each emptying two lanes of traffic, of course receives, altogether, 8 lines of vehicles. The total maximum hourly flow under these conditions would be 900 multiplied by 8, or 7,200 vehicles. This number is on the basis of continuous movement on each of the several lanes. Experience has shown that the maximum hourly traffic is 8.2 per cent of the total daily traffic, although it varies according to local conditions. The daily traffic at such an intersection would therefore be approximately 87,840 vehicles. However, the traffic circle would have to be designed to serve 7,200 vehicles per hour.



(*a*) Mt. Laurel (*b*) Egg Harbor

FIG. 3. EXAMPLES OF SPLIT TRAFFIC CIRCLES IN NEW JERSEY

If this volume of traffic were to be cared for without any diminution of speed through the intersection, it would be necessary to give the circle a radius of 600 ft. Obviously this size would be most extravagant in all but the most exceptional cases—especially since it is entirely practicable to care for this traffic more safely in a smaller circle at a reduced speed. Under nearly all normal conditions, a traffic circle with a radius of 150 ft. and a roadway width of 50 ft. would be able to pass this traffic safely through the intersection at a speed of 20 miles an hour. To maintain a speed of 15 miles an hour through the intersection would require a circle with a radius of about 80 ft.; and to maintain that of 25 miles an hour, a radius of about 225 ft. A radius of 100 ft. would probably be found sufficient to serve the normal requirements of almost any average intersection. It is doubtful, even under city conditions and with moderate volumes of traffic, whether a traffic circle should ever have a smaller radius than 50 ft.

Of course traffic circles carrying excessively heavy volumes of traffic must have larger radii. In New Jersey, where more traffic circles have been constructed in recent years than in any other state, the radii of different circles vary all the way from 75 to 160 ft. The latter size is that of the Kaighn Avenue circle at Camden. The State Highway Commission of New Jersey has designed circles with radii up to 200 ft. It seems to favor the larger radii for the reason that small circles unduly restrict the speed of traffic.

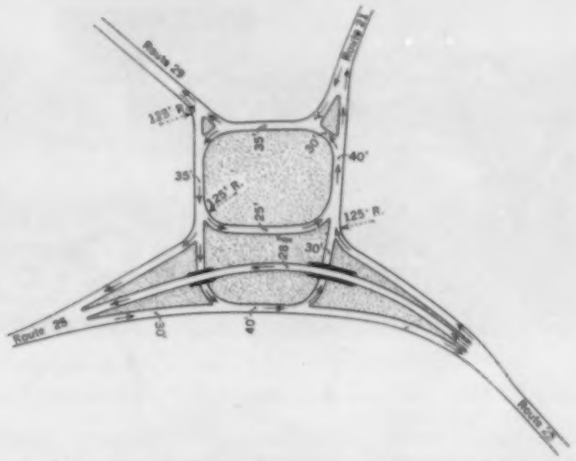


FIG. 4. A TRAFFIC CIRCLE COMBINED WITH A GRADE SEPARATION AT NEWARK JUNCTION, N.J.
Occupies 11 Acres and Has a Capacity of 200,000 Vehicles per Day

Irregular traffic circles generally occupy a greater area than true circles. The perimeter of some of these irregular circles is several times the circumference of the Kaighn Avenue circle. This true circle has a circumference of about 1,000 ft. The perimeter of the irregular traffic circles at Collingswood, Fairlawn, and Little Ferry (Fig. 2), is about 1,400 ft.; that at Egg Harbor (Fig. 3), about 2,000 ft.; and that at Newark Junction (Fig. 4), about 2,400 ft. These estimates ignore the roadway lengths included in the approaches and the supplementary lanes within the circles themselves.

The chief advantages of a grade separation are two: it eliminates all turning movements in so far as through traffic is concerned; and it avoids the weaving to which all traffic must submit in a traffic circle. A grade separation therefore makes possible a much greater speed for all through traffic. But here the advantages of a grade separation seem to cease. A properly designed traffic circle is probably capable of caring for as much traffic as should ever be allowed under normal conditions to accumulate in one place. For instance, the Kaighn Avenue circle in Camden carries on peak days, according to traffic counts, approximately the same amount of traffic as the four-leaf clover grade separation at Woodbridge. Both have cared for over 60,000 vehicles per day. In neither case has any clogging of traffic been observed by the state highway authorities. There is,

however, a considerable economy of land in the use of a traffic circle. Some of the four-leaf clover separations, such as that at Woodbridge, utilize from 20 to 25 acres. The Kaighn Avenue circle at Camden, however, covers only about two acres of ground.

Where two intersecting streets would cross at a very acute angle, the length of the traffic oval may be so long in some instances as seriously to inconvenience left-hand movements between the two streets. To reduce the distance that such traffic must travel, it has been found feasible to split the traffic circle so that left turns may be made without going all the way round the large circle. In other words, the traffic circle is really divided into two minor circles, the smaller ones being utilized by some of the left-hand movements and the large circle by the remaining traffic.

PLACE DE L'ETOILE, PARIS
A Traffic Circle Used by Street Cars

Splitting the circle thus has the effect of reducing the distance that must be traveled by vehicles desiring to make left turns. It also reduces the amount of traffic near the entrances of the various streets. This distribution of rotating traffic relieves congestion at some of the most critical points in the traffic circle. Good examples of the split traffic circle are found at Mount Laurel, Egg Harbor, and Newark Junction.

The bridged traffic circle is a recent innovation in highway design. In a sense, it is a cross between a traffic circle and a separation of grades, the circle being utilized for a general distribution of the miscellaneous traffic among the streets entering the intersection, and the bridge reserved for a direct routing of heavy through traffic across the circle. The purpose of this division is to save the large volume of through traffic the inconenience of rotating around the circle.

Where the highways are called upon to carry an excessive volume of traffic, it is of course desirable to have all the traffic entering an intersection discharged from it in the least possible time. Where the predominant part of this heavy load is through traffic, and therefore readily segregated from the miscellaneous interchange movements of the intersection, a real advantage may be gained by keeping this traffic entirely out of the circle and routing it directly to its destination. By bridging the circle for this main traffic movement, it is possible to obtain at a single intersection the combined advantages of both a separation of grades and a traffic circle. A good illustration of the bridged circle is now under construction at Newark Junction.

In the past, except for officers and signs directing traffic, vehicles could as easily turn to the left as to the right on entering a traffic circle. It has remained for the State Highway Commission of New Jersey to build circles that almost automatically route traffic in the desired direction.

Regulatory control over traffic has been built into the very structure of the circle. Islands located at the entrance of each street are so designed as practically to prohibit left turns. Through ingenious widening and narrowing of various parts of the roadway, traffic is unconsciously apprised of the intended main and minor traffic movements. The design of the circle makes it easy for drivers to take the right path through an intersection, and difficult to take the wrong one.

ABILITY OF TRAFFIC CIRCLES TO SERVE TRAFFIC

There are at least three factors that bear upon the circle's ability to serve heavy volumes of traffic: (1) its turning radius, (2) its perimeter, and (3) its roadway width. Too small a radius makes it difficult for vehicles to keep within their respective vehicular lanes. It also unduly restricts their speed. But above all, it makes it decidedly difficult for machines to weave quickly in and out of traffic on entering and leaving the circle.

TRAFFIC CIRCLES IN WASHINGTON D.C.
Thomas Circle, with Street Cars; Scott Circle, with Built-in Traffic Control

The distance around a circle is just as decisive a factor as its turning radius in determining the volume of traffic that can be readily distributed in any given time. The normal roadway intersection is usually a rectangular space, the greatest dimension of which is not more than 40, 56, or 72 ft.

The traffic circle frankly recognizes that this small rectangle is utterly incapable of coping with its problem satisfactorily. It substitutes, in lieu of this tiny area, a stretch of roadway with a width, for at least part of its length, usually as great as the width of the widest roadway entering the intersection and with a length, even

in small circles, of seldom less than 500 ft. In the case of large circles, this roadway length may exceed 2,000 ft.

As a rule the width of the widest roadway entering the intersection should suffice for the width of the roadway around the circle. That a wider roadway is not required around the circle may come as a surprise to many people. Traffic within the circle will naturally proceed at a much slower speed than on the main highway. But the spacing between vehicles remains the same as on the highway itself. With a speed of 40 miles an hour, the capacity of an unobstructed traffic lane is about 900 vehicles per hour. The safe spacing distance of vehicles at that speed is 230 ft. With a speed of 20 miles an hour, its capacity, though under the circumstances unused, would be 1,500 vehicles per hour. The safe spacing distance of vehicles at this speed is 69 ft. Vehicles passing through the circle would, however, despite this reduction in speed to 20 miles per hour, still be spaced 230 ft. apart. In other words, the diminution of speed within the circle leaves a large gap between the actual used capacity of the circle and its potential capacity at the same speed. It is this difference in spacing between 230 ft. and 69 ft. that enables vehicles to weave without difficulty or increased accident hazard across the necessary traffic lanes in passing through a traffic circle. In fact, both the lower speed of cars and the increased spacing between them appreciably reduce the accident hazard. Obviously, a roadway wider than a certain minimum width would not, under these circumstances, appreciably aid this weaving process. The weaving faculty of traffic is far more dependent upon such factors as the turning radius of the circle, the size of the circle, and the volume of traffic within it at a particular moment, than it is on the width of the roadway itself.

Long Island State Park Commission

TRAFFIC CIRCLE AT ENTRANCE TO JONES BEACH, LONG ISLAND, N.Y.
Water Tower and Central Mall

TWIN TRAFFIC CIRCLES AND RAILROAD UNDERPASS, BROOKLAWN, N.J.

Briefly summarized, the results of experience with the traffic circle may be stated as follows:

1. The size and turning radii of a traffic circle are the chief considerations in determining its capacity.
2. A sufficient space between entering streets is of the utmost importance to the successful movement of traffic within a circle.
3. The traffic circle is the most efficient way of caring for traffic at multiple intersections.
4. The traffic circle attains its highest efficiency when all traffic using it circulates in perfect harmony with the general rotary movement of the circle.
5. The safety of traffic within the circle varies, within limits, inversely as the size of the circle.
6. The desired control over traffic should be built into the circle through the use of traffic islands and variations in roadway width to indicate major and minor traffic movements.
7. A large circle may be split advantageously in order better to serve the needs of traffic.
8. As a rule, it may be said that a traffic circle is more economical to construct than a grade separation.
9. A bridged traffic circle may greatly facilitate traffic movement by separating straight traffic from turning traffic and delivering the latter to the traffic circle for distribution.

TRAFFIC CIRCLES COME BACK INTO FAVOR

Since thoroughfare planners and designers in this country had almost lost sight of the traffic circle, the State Highway Commission of New Jersey may almost be said to have reintroduced it. It seems evident that, in serving large volumes of fast traffic, it compares favorably with such grade separations of intersecting streets as have been constructed up to the present. Indeed, there are many intersections that could not possibly be satisfactorily served with either an underpass or an overhead crossing, but which lend themselves splendidly to treatment by a traffic circle.

Because of its great adaptability to different conditions and its capacity for serving large volumes of fast traffic as rapidly as it is fed in by the entering streets, there may be predicted for the traffic circle a long and useful future in the design of our great trunk highways.

The Future of the Railways

A Statement of Their Place in Our Transportation Industry

By RAYMOND B. KITTREDGE

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PROFESSOR OF TRANSPORTATION ENGINEERING, STATE UNIVERSITY OF IOWA, IOWA CITY

ALTHOUGH the fundamental service rendered by the railroads is in transportation, 40 per cent of their bonds are held by insurance companies and savings banks. Through these agencies alone railroad securities may be considered as an investment of almost every American family. Next to agriculture, the railroad industry is the greatest in the United States; it has a capital investment of 26 billion dollars and in 1930 employed over a million and a half workers, whose aggregate wages, or buying power, were more than two and a half billion dollars. During that year the railroads spent for wages, supplies, taxes, fuel, and other necessary items the immense sum of nearly four billion dollars. According to Professor Kittredge, their well being is so tied up with the whole economic fabric of our nation that they should be permitted to earn on their investment the "fair return" which they must have in order to exist. In 1931, the percentage earned on their property investment was but 2 per cent.

In this article he discusses the effect on the railroads of onerous Government regulation, and of growing competition from motor truck, waterway, and pipe line, and from the automobile and airplane. Congress and the Interstate Commerce Commission have the responsibility and the power to regulate all these public carriers so that each, by supplementing the usefulness of the other, will be permitted to grow and prosper. He concludes that if the railroads, which are essential transportation facilities, are to continue to exist, their problems must receive the early consideration of our national legislators.

IN JUNE 1931, when the railways of the United States proposed to the Interstate Commerce Commission that they be permitted to increase by 15 per cent all freight rates and charges, attention was called to a situation in this industry that is of vital importance to every inhabitant of the country. This petition resulted in public expressions both of sympathy and of antagonism. Some editors and organizations, realizing the critical condition of railway finances and the importance of the industry to the country as a whole, urged that the commission act upon the petition favorably and at once. Others, while expressing sympathy with the railways, gave voice to the fear that the proposed increases in rates would tend to prolong the business depression and would not in fact result in increasing revenues. Still others, habitually antagonistic to the railways, insisted that their high rates were one of the causes of the depression, and maintained that decreases rather than increases were in order.

The average citizen is seldom sympathetic when capital alone is in distress. An industry involving the investment of some $26,000,000,000 may cry aloud for help without reaching many sympathetic ears until the public realizes that millions of just ordinary citizens, not commonly classed as capitalists, are immediately interested in the return on the capital invested in that particular industry, that millions more directly or indirectly derive their support from its operations, and that it is engaged in furnishing a service essential to agriculture and to every other industry and indispensable to the welfare of every person in the country.

Nearly a million individuals own stock directly in the railways of the United States, and the number of bondholders is probably even greater. Banks and insurance companies invest a substantial part of their funds in railway securities, and the number of depositors in savings banks alone now exceeds fifty million. Probably more than half the population of the United States should be considered as among the owners of the railways, and directly interested in the return on this investment. When, as at present, the earnings of these carriers are so small as to threaten their operating efficiency and to impair their credit so seriously that many railway bonds are in danger of losing their standing as legal investments for savings banks and insurance companies, the situation becomes of vital importance to the general public in more ways than one.

As employers of labor, the railways rate among the most important of the country's industries. When drastic economies demanded by falling revenues result in a sharp reduction in the number of railway employees, the contribution to unemployment is substantial. For the past ten years, the average number of employees of the Class 1 railways of the United States has been approximately 1,750,000, and their aggregate yearly compensation has averaged nearly $3,000,000,000. The railways are among the most important customers of many a business concern, and they spend in a normal year something like $1,250,000,000 in the purchase of fuel, materials, and supplies (Fig. 1). When their expenditures are sharply curtailed, the results are felt far and wide, and the army of the unemployed gets more recruits.

The railways also deserve some consideration as taxpayers. During the last ten years, the taxes paid by the Class 1 railways of the United States have averaged about $350,000,000 yearly, or nearly a million dollars a day. State and local taxes account for the greater part of these sums, and many a local unit of government would be in serious financial straits if it were not for taxes received from railways.

MOST IMPORTANT SERVICE RENDERED

In addition to their importance as borrowers, as employers, as customers, and as taxpayers, the railways are furnishing a transportation service without which the country would be helpless. The time may come

when they should be scrapped, along with other agencies of transportation that have outlived their usefulness, but at least for a long time to come they must remain the most important factor in our transportation industry. Highways, waterways, airways, and pipe lines can do much to supplement the service they offer, but by no reasonable flight of the imagination can these facilities be expected, in the reasonably near future, to replace them. To get along with the railways may at times seem difficult; to get along without them would indeed be impossible.

FIG. 1. OPERATING EXPENSES OF CLASS 1 RAILWAYS FOR CALENDAR YEAR 1930; TOTAL $3,930,928,687

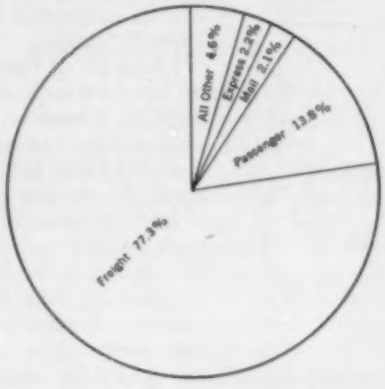


FIG. 2. OPERATING REVENUES OF CLASS 1 RAILWAYS FOR CALENDAR YEAR 1930; TOTAL $5,281,196,870

Of importance in studying the railways and their present predicament is an understanding that the interests of the public and those of the carriers are never so antagonistic as they are often made to appear. The railways can thrive only as the country is prosperous, and only successful railways can furnish the kind of transportation service that is indispensable to the prosperity of the country.

The railways of the United states are in fact in a critical condition, and the most effective remedy is not clearly indicated, but the American people can be trusted, when they understand the seriousness of the situation and the vital importance to the country as a whole of a prosperous condition of this most important industry, both to find the proper remedy and to see that it is effectively administered. Fully as serious an emergency existed when the railways were returned to their owners following their operation by the Government in the interest of winning the war, and that emergency was met, and in the main met well, by the Transportation Act of 1920.

MUST PAY A "FAIR RETURN" ON INVESTMENT

The fundamental trouble now is that the net railway operating income is not sufficient to pay a reasonable return on the invested capital and to support the credit of the industry so that it can obtain on favorable terms the capital necessary for the maintenance at all times of such transportation service as is essential to the prosperity of agriculture and commerce. This condition would not be a cause for great concern if it were only the result of a business depression which must inevitably end, and if the railways were allowed to earn something more than a fair return in times of economic prosperity. But even in times of general prosperity railway earnings are rigidly restricted, and even after due allowances are made for the effects of a temporary business depression, all is not well with railway revenues.

"Net railway operating income" is what is left after operating expenses, including taxes and equipment rentals, are deducted from operating income, and it represents the net return on the investment in property "held for and used in the service of transportation." For the five-year period ending with 1929, the total yearly operating revenues of the Class 1 railways of the United States averaged about $6,300,000,000, of which freight revenue accounts for about 75 per cent; passenger revenue for a little more than 15 per cent; and mail, express, and "all other revenue," for the balance. The "net railway operating income" averaged a little more than $1,150,000,000, or about $4^3/_4$ per cent on the property investment. Although this was considerably less than a "fair return" as contemplated by Section 15*a* of the Transportation Act of 1920, it still resulted in a fair degree of prosperity for the railways. Their capitalization is considerably less than their property investment, and after interest charges were paid, the sum available for dividends was a reasonable percentage of the capital stock. The division of the operating revenue for 1930 between the various sources is shown in Fig. 2.

For 1930 and 1931 the results were much different, as may be seen from an examination of the chart in Fig. 3. Even with a conservative financial structure, returns on property investment of about $3^1/_2$ per cent in 1930 and of only about 2 per cent for 1931 are not sufficient to maintain railway credit, and unless substantial improvement is effected, and effected soon, the results may well be disastrous. Stockholders may be willing to go without dividends for a while, but an industry that does not earn interest on its bonds is threatened with trouble immediately.

DEPRESSION NOT ALONE RESPONSIBLE FOR RESTRICTED EARNINGS

It is doubtless true that the railways must expect to suffer along with other industries in times of business depression, but the difficulty is that these carriers, unlike most industries, are rigidly restricted as to earnings even in times of general prosperity. From the present situation one lesson may be learned. In prosperous times the railways should be allowed to earn something more than a fair return to tide them over the periods of depression which as yet seem inevitable. Had this been the practice in the past, there would not now be cause for such great concern. The provisions of the Transportation Act of 1920 that were intended to make it possible to recapture some of the "excess earnings" of the railways appear less desirable now than they did in 1920, and the demand for their repeal comes not alone from the carriers themselves.

Business in general is due to improve before long, and the resulting increase in railway traffic will help relieve the situation, but unfortunately the depression is not the sole cause of the trouble. Discounting the effect of the depression, traffic has not been all that could be desired. Once, many of the problems of the railroads were solved by a growing traffic which doubled in volume about every ten years, but those happy days seem to have gone forever. In 1929, the freight service of the railways, measured in net ton-miles, was less than 10 per cent greater than in 1920, and during the same period their passenger revenue had decreased by some 34 per cent. Competition by motor vehicles is largely responsible for the loss in passenger revenue, and partly

responsible for the slowing up in the growth of freight traffic.

COMPETING FACILITIES MORE FAVORABLY REGULATED

Competition by means of highways, waterways, airways, and pipe lines now confronts the railways; and the indications are that this competition will increase rather than diminish. The growth in passenger traffic and in the movement of high-grade freight by highway will continue as the mileage of improved roads is extended; the development of inland waterways will mean the movement of more tonnage of bulk freight over long distances by water; the rapid extension in the mileage of pipe lines will be reflected in the tonnage of petroleum products and coal carried by rail; and the effect of airway transportation on passenger, mail, and express traffic may yet become serious.

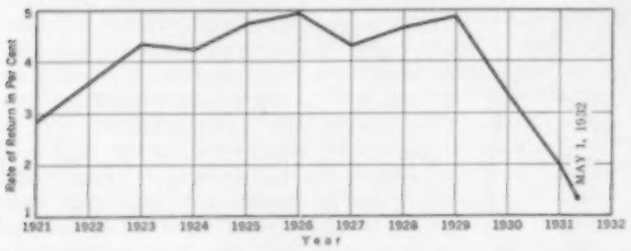


FIG. 3. RATE OF RETURN EARNED BY CLASS 1 RAILWAYS ON PROPERTY INVESTMENT
Including Cash, Materials, and Supplies

Disturbed by the outlook for the future, the Association of Railway Executives held a meeting in New York City on November 20, 1930, at which the executive committee and member roads unanimously adopted a "Declaration of Policy Deemed Necessary to the Continuance of Adequate Transportation Service to the Public." At that time they recommended a temporary suspension of action by regulating bodies and legislative assemblies, both state and national, which would adversely affect rates or increase the expenses of the carriers. They requested a withdrawal of governmental competition, both indirectly through subsidies and directly through governmental operation of transportation facilities, and a system of regulation, fairly comparable to that to which the railways are subjected, for competing services on waterways and highways. They suggested the enactment of appropriate legislation for the adequate regulation of motor buses and trucks, with no discrimination against railways operating in the same field. They asked for sympathetic administration of the long- and short-haul clause of the Interstate Commerce Act to allow the railways to compete with traffic on the Panama Canal, and for a modification of the Panama Canal Act to permit the operation of waterway service in conjunction with rail service.

WITHDRAW GOVERNMENTAL COMPETITION

Some of these suggestions will be more popular than others. The withdrawal of governmental competition would probably be more violently opposed than the temporary suspension by regulating bodies of action that would decrease the net operating income of the railways. The Government is in the habit of aiding financially the development of transportation facilities; the demand for continuation of that aid will be strong. Less opposition may meet the proposal that the railways be allowed, under proper regulation, to operate waterway service in conjunction with rail service. The fear of "big business" in general, and of monopoly in transportation in particular, is by no means as great as it was only a few decades ago.

Today much support might be found for a legislative policy that would allow the development of companies unrestricted as to the mediums they may employ, and free to use either rails, highways, water, air, or any combination of these mediums that seemed most likely to secure the desired results. Whatever else may be said about this declaration of policy by the railroads, it certainly deserves the thoughtful consideration of anyone who is interested in the future of transportation in the United States.

As a part of the cost of transportation, the return paid on invested capital is naturally of interest to the general public. However, even during the comparatively prosperous period from 1925 to 1929, it represented less than a fifth of the total cost of railroad transportation paid by the American public.

Capital charges might be lower if the Government were to own and operate the railways, and this partial solution of the problem is not without its enthusiastic supporters, but the opinion of the majority in this country is clearly in favor of private ownership and operation. The advantages of government ownership are generally believed to be much more than offset by its many disadvantages.

Granting private ownership and operation, the problem becomes one of regulation, and regulation not only of the railways themselves but probably also of the other transportation agencies with which they compete. Government regulation must accompany private ownership and operation. After studying the history of the railroads in the United States, only an incurable optimist would ever believe that the best interests of the public would be served by removing all such regulation. But the question may well be asked at this time if the public is not now going too far. Regulation may overlook the rights of the owners of the railways in its zeal for compelling them to fulfill their obligations, and if carried too far may assume altogether too many of the functions of management.

If the railways are to be privately owned and operated, justice, common law, statute law, and common sense all insist that the owners must receive a fair return on the fair value of their property, reasonably used in the service of transportation. Any other program must eventually fail.

PUBLIC RESPONSIBILITY FOR REGULATION

The questions as to what constitutes a fair valuation of the railways for rate-making purposes, and what would be a fair return on that valuation, have always been and perhaps always will remain debatable. But if the railways are to be privately owned and operated, it seems clear that the return on the invested capital must be at least sufficient to enable them to obtain on favorable terms, in a competitive market, such capital as is reasonably needed to maintain their properties in excellent condition and to furnish the efficient transportation service so essential to the welfare of the public. Under private ownership and governmental regulation, the responsibility for this result is divided between the managers of the railroads and the public.

It is undoubtedly true that railway management is open to some criticism, particularly when the railways of the United States are considered as one great system rather than as individual properties, but since 1920 improvements in operating efficiency and generally satisfactory service have warranted the belief that, in the main, railway managers have done their part. Both

estimates of the savings due to improved operating efficiency, and calculations of the economic value to agriculture and industry of rapid and dependable service, must be expressed in such large sums that they challenge the imagination. Whether the public has done as well in meeting its responsibilities to the railways is open to question.

The public is responsible for much restrictive regulation—for the expenditure of large sums of capital in improvements that produce little if any additional railway revenue; for the extent to which public aid is given to transportation agencies that take traffic away from the railways; and for the regulation, or lack of regulation, of those competing agencies. It is true that railway officials in the early days had only themselves to blame for the first restrictions placed upon the carriers, but the public has the major responsibility for the extent to which restrictive legislation has developed and will have a similar responsibility for the regulation of the future.

A study of the history of the railroads reveals much that stands to the everlasting credit of those pioneers in transportation who made possible the United States as we know it today, but it uncovers as well certain vicious practices, which inevitably brought many difficulties to the present generation of railway executives, who must suffer now for the sins committed by their predecessors in a past that is already growing remote. Whether the worst railway executives of the present would be as bad as the worst of the past is a question that loses much of its importance when it is realized that they could not be if they would.

From the time of the first railway construction in America, the carriers have been subject to some form of governmental regulation, but up until about 1870 public interest was centered on the extension of mileage rather than on the development of governmental control. For the time being, reliance was placed on competition as an effective regulator of railway rates and practices, and the demand was for more and more railroad construction. Public funds had previously been expended for the development of turnpikes and waterways; and when the railways had proved their worth, enthusiastic support was extended to this new form of transportation. State vied with state and community with community in granting land, conceding tax exemptions, purchasing stocks and bonds, and even in making outright donations of cash and securities. Public benefits resulting from the construction of railways were undoubtedly far in excess of the amount of public aid thus extended.

WHERE THE RAILROAD DOLLAR GOES

Out of the gross railroad revenue of the year 1930, it took the receipts of 157 days for wages; 66 days for material and supplies; 51 days for interest and rents; 29 days for all other operating expenses; 24 days for taxes; 20 days for dividends; and 19 days for locomotive fuel. These data are from statistics furnished by the Bureau of Railway Economics. The railroads failed to earn dividends in 1930. In addition to dividends paid to stockholders from current earnings, they paid the equivalent of 14 days of gross receipts from the earnings of prior years.

ABUSES DEMANDED REGULATORY LEGISLATION

By 1870 the attitude of the public toward the railways had undergone a radical change, and an insistent demand for effective regulation found expression, particularly in the Middle West, in the form of state legislation intended to control the many abuses that had arisen. Causes contributing to this change of attitude were the financial mismanagement of the railways; their activities in politics; unjust discrimination between places, individuals, and commodities; and the supercilious attitude of some railway officials, so aptly expressed in that oft-quoted phrase of one of them, "The public be damned." Among the results were the so-called Granger legislation of the seventies and a series of court decisions that established beyond all doubt the right of the public to regulate its railways.

The rapid expansion of the railways, the growth in importance of interstate business, and the decision of the Supreme Court in the Wabash case, in 1886, holding that the power to regulate interstate commerce was vested exclusively in the Federal Government, led up to the passage in 1887 of the Act to Regulate Commerce. This act created and established the Interstate Commerce Commission and marked the real beginning of Federal control of the railroads of the United States. Important amendments have been added by the Elkins Act of 1903, the Hepburn Act of 1906, the Mann-Elkins Act of 1910, and the Transportation Act of 1920; and these acts, together with the Panama Canal Act of 1912 and the Valuation Act of 1913, have profoundly affected the development of the railroads and very materially extended the scope of Federal control.

While the Act to Regulate Commerce, as originally passed in 1887, required that all charges for services should be reasonable and just, it was intended primarily not to lower rates believed to be excessive, but to correct the recognized evils of rate discrimination. The general level of rates was not at that time a matter of complaint, but gross inequalities in them, disturbing to both industry and agriculture, brought a popular demand for an effective remedy.

The Elkins Act of 1903 was passed at the request of the railways themselves in the hope that rebating and other forms of discrimination would be completely eliminated. The Hepburn Act of 1906 further extended the field of Federal regulation, strengthened the law with reference to rebating, definitely stopped the abuses which had arisen as a result of the wholesale issuing of free passes, and for the first time gave the Interstate Commerce Commission the right to determine and prescribe just and reasonable maximum rates. The Mann-Elkins Act of 1910 still further extended the jurisdiction of the Interstate Commerce Commission, strengthened the long- and short-haul clause of the Act of 1887, gave the commission power to suspend proposed changes in rates, and placed on the railways the burden of showing justification for increases in rates.

When the Panama Canal Act of 1912 became effective on July 1, 1914, the railways were prohibited from owning, operating, or having any interest whatever in any common carrier by water, through the Panama Canal or elsewhere, when the effect was, or might be, to lessen competition for traffic. The railways are thus prevented from meeting waterway competition with waterway services of their own. The question has frequently been asked if the time will not soon come, or if indeed it is not already here, when the provisions of this act should be modified to permit, under proper regulation, railway operation of carriers by water.

EVALUATION OF A RATE BASE

The Valuation Act, approved on March 1, 1913, requires the Interstate Commerce Commission to investigate, ascertain, and report the value of all the property owned or used by every common carrier subject

to the provisions of the act. An authoritative valuation of railway property was deemed important as a basis for the determination both of reasonable railway taxation and of reasonable railway rates. Many people believed that the valuation of railway property by the Interstate Commerce Commission would show the existence of much "water" in railway stock. Instead, the results of the valuation as reported to date show that the net capitalization of the railways as a whole is much less than their property investment.

Whether the railways' "book" value of "property investment" is a proper base upon which to compute the rate of return has long been a debatable question and perhaps it always will be, but as long as the Supreme Court maintains the position that it has held consistently since the Smyth vs. Ames case of 1898, much can be found to support the belief that the basis of a fair return should be not less than the amount of this property investment.

For 26 months, beginning January 1, 1918, the railways were operated under Federal control in the interest of winning the war. The war was won. Just who won that war seems to remain a matter of debate, but the railways played their part and were returned to their owners somewhat the worse for wear on March 1, 1920. Since September 1, 1920, their earnings have not been guaranteed.

INTERSTATE COMMERCE COMMISSION RECOMMENDATIONS

Whatever faults the Transportation Act of 1920 may be thought to have, it was certainly a constructive piece of legislation which met a serious emergency and met it well. The problems involved in returning the railways to their owners and at the same time protecting their labor, maintaining their credit, and providing transportation sufficient for the needs of the country, were among the most important and the most difficult of all the problems of reconstruction confronting the United States at the end of the World War. The Transportation Act met them squarely and solved them well.

In addition to providing for the termination of Federal control, this act effected radical changes in Federal policies of regulation and placed the railways more than ever under the control of the Interstate Commerce Commission. The commission was given the power to fix minimum as well as maximum rates, and on it was laid the duty to initiate rates so that the carriers as a whole would earn a net railway operating income equal, as nearly as might be, to a fair return on the value of their property held for, and used in, the service of transportation.

In no year since 1920 have the Class 1 railways earned a rate of return on their property investment as great as the 5 3/4 per cent now declared to be fair. A majority of the Interstate Commerce Commission have apparently come to believe that, although sound in principle, the rate-making rule of the Transportation Act is impracticable in certain respects. A number of changes have already been recommended by the commission, and important legislation affecting the railways is sure to receive consideration during the present session of Congress. Public opinion will be influential in shaping whatever legislation is to be enacted.

EQUAL REGULATION NEEDED FOR ALL FORMS OF TRANSPORTATION

Without a doubt this country can support any form of transportation for which it has the need, and in the long run the public can and must pay all its transportation bills. The Government will continue to extend some measure of financial aid to transportation by water, by highway, and by air. Even more important in the interest of the public is the continuation of adequate and dependable transportation by rail. Regulation to preserve such transportation is a primary responsibility of Congress and the Interstate Commerce Commission, and these agencies of the public should be free to exercise their best judgment without the necessity of considering questions of political expediency. Meanwhile, the country needs the railways, and the railways need traffic.

Courtesy National Electric Light Association

A 104-CAR TRAIN PASSING THROUGH THE CASCADE MOUNTAINS
Three-Fourths of the Income of Class 1 Railroads Is from Freight

Safety Islands—Their Design and Use

To Prevent Accidents and Facilitate the Movement of Pedestrian and Vehicular Traffic

By D. Grant Mickle

Junior American Society of Civil Engineers

Traffic Division of the Department of Public Works, Commonwealth of Massachusetts

PEDESTRIANS and motorists alike benefit by the introduction of safety islands at strategic points. Intersections that provide too much roadway space often cause as many accidents and as much delay and confusion to vehicles as those that provide too little. Obviously, such intersections constitute danger points for pedestrians desiring to cross them. Pedestrians also need the protection of safety islands while waiting to board trolleys. Mr. Mickle reviews many types of safety islands and describes various kinds of obstructions erected to protect the pedestrians using them. He points out that although the safety of pedestrians is paramount, motorists must also be provided with all possible safeguards against collision with any obstructions placed in the roadway. The study on which this article is based was made while Mr. Mickle was a Fellow in the Albert Russel Erskine Bureau for Street Traffic Research, Harvard University.

IT may be said that safety islands are of three general types: (1) those placed in the roadway to control and regulate traffic movement; (2) those that act as separation strips between sections of major arterial roadways carrying opposing streams of traffic; and (3) those having as their primary purpose the protection of pedestrians. Traffic circles may also be considered as islands placed at large intersections for the purpose of controlling traffic, but they are a special form of control and will not be considered in this article.

It is well known that traffic movement is less efficient and results in greater confusion when the area allotted to it is too spacious. The average motorist needs physical guidance. This fact was illustrated soon after the opening of Wacker Drive in Chicago. At two of the intersections along the drive, both of which were of unusual size and shape, the confusion and delay were so great and the accidents so many that the efficiency of the new roadway was seriously impaired. It was necessary to construct several islands blocking off large open spaces in the intersections before traffic could be moved through them safely and effectively.

Many other cities have found it advantageous to block out certain parts of confusing intersections. In Detroit, the numerous diagonal streets intersect in such a way that frequent large and irregular intersections are formed. If it were not for the islands shown in one of the photographs, that of the intersection of Woodward Avenue at Cadillac Square, traffic would become hopelessly confused and many accidents would result.

In San Francisco there is the same problem, for Market Street cuts diagonally across the rectangular street plan of the business district. The resulting irregular intersections have made necessary the use of large triangular shaped islands, as illustrated, to organize and control traffic. These islands are also of benefit to pedestrians on their long trip across the intersection.

Separation of opposing streams of traffic is desirable but frequently impossible because of inability to obtain sufficient right-of-way. This is especially true in the more congested areas where land values are high and property damages extreme. The new Charles Street development in Boston is one of the few examples of a double roadway in the congested district of a city. Here the required width was obtained by filling in along the bank of the Charles River. In this particular development, the center strips act not only as a separation for traffic and a protection for pedestrians but also as "filter islands." Breaks in the center plot are made midway between cross streets instead of directly opposite them. Since no direct cross movement is possible, entering traffic desiring to turn left must first turn right, filter across the roadway with the traffic, and then make the left turn at the mid-block break, availing itself of the protection of the center island.

Where Memorial Drive underpasses Massachusetts Avenue in Cambridge, Mass., a raised concrete curb has been placed down the center of the roadway. This separation of opposing traffic streams largely prevents

Woodward Avenue at Cadillac Square, Detroit

(C) San Francisco Traffic Commission

An Intersection Along Market Street, San Francisco

vehicles from usurping more than their rightful share of the roadway, so that accidents caused by cars passing while in the underpass are avoided.

Perhaps the most common use of separation strips is on highways outside congested districts. Wayne County, Michigan, has for several years been engaged on a super-

MEMORIAL DRIVE, CAMBRIDGE; UNDERPASS AT MASSACHUSETTS AVENUE
A Raised Curb Separates Opposing Lines of Traffic

highway development involving the construction of many miles of road made up of two pavement strips, one for each direction, separated by wide grass plots. The new Worcester Turnpike being built between Boston and Worcester, Mass., is so designed that the two roadways are separated by long narrow islands on which shrubs will be planted to reduce headlight glare at night and to enhance the beauty of the highway. It has been suggested that greater safety would be secured by the use along the separation strip of a curb with a less sharp bevel. A vehicle forced against or into the sharp ledge shown in the illustration would have little chance of avoiding an accident, whereas if a concave curb were substituted, a driver could run against or along it with little if any resulting harm.

Streets or highways on which the opposing streams of traffic are separated by some physical means make possible not only faster but also safer movement of traffic. Passing can be accomplished without the fear that an oncoming car will appear to hurry the passage and perhaps force one of the cars off the road. Headlight glare at night is materially reduced and the possibility of head-on collisions is eliminated.

PEDESTRIAN ISLANDS

Pedestrian islands may be divided into two groups: small islands of refuge for the protection of pedestrians as they cross wide, heavily traveled streets; and safety strips used as loading areas for street cars. Of the first group, perhaps one of the best examples is to be found on North Michigan Avenue in Chicago. The street is wide and carries a large volume of fast traffic. Shops occupy the frontage for a number of blocks north of the Chicago River, so that there is considerable cross movement of pedestrians at the various intersections.

Small islands have been placed in the center of the roadway, in the crosswalk. They serve not only as places of safety for pedestrians caught between streams of moving traffic, but also as turning points for vehicles wishing to go into or off of Michigan Avenue. Had the islands been located back of the inside edge of the crosswalk, and raised buttons placed at the points where their prolonged edges intersect the outside edge of the walk, much of the annoyance occasioned by stepping on to and off of the raised platform would have been avoided. The raised buttons would offer sufficient protection against vehicles passing through the crosswalk area.

The second group of pedestrian islands, those used as loading zones for street cars, are valuable in that they not only protect street-car passengers and pedestrians but, when properly designed and located, also facilitate traffic movement. Where there are no physically outlined loading areas, vehicles are required to stop at the rear of street cars as they load or discharge passengers, and considerable annoyance and delay as well as accidents result. If some form of protection is provided passengers at loading points, and if proper parking regulations near this area are enforced, it is possible for automobile traffic to move continuously, regardless of the stopping and starting of street cars. Obviously, free traffic movement is desirable for automobiles and street cars alike.

Loading areas may be considered under two general headings, those offering real physical protection, and those which may be said to give only mental protection. In the second class are included zones set off by light

WORCESTER TURNPIKE BETWEEN WORCESTER AND BOSTON, MASS.
Narrow Raised Planting Strip Placed Between Opposing Lines of Traffic

stanchions and those formed by paint lines or small metal buttons in the pavement. In the first group are included areas protected by raised buttons or outlined by posts, and concrete or steel platforms with end buttresses. Only zones offering actual physical protection will be considered here, for it appears that those without such protection should not be designated as safety zones or islands, but merely as loading areas. A pedestrian or street-car passenger enters a loading area marked "safety zone" in the belief that he is protected from vehicles while within the limits of the zone. This faith should be justified.

The characteristics of traffic movement on streets in congested or central business districts are far different from those on the arteries feeding such districts. In the central area, movement is slower and more cautious and is confined to more definite lanes. Speeding, passing, and cutting in and out of line are less frequent. In general it may be said that movement is more easily regulated and that operators have greater control of their machines. This fact at once indicates that a type of loading zone which is perfectly safe for streets in the congested district may not be at all suited for use on arteries where higher speeds obtain.

ISLANDS ALONG NORTH MICHIGAN AVENUE, CHICAGO
Refuge Points for Pedestrians Crossing a Wide Street

AREAS OUTLINED BY RAISED BUTTONS

One of the most common types of loading zones in use is that outlined by raised buttons. Among its main advantages is the low cost of installation and maintenance. Where traffic movement is fairly slow, this type of zone gives reasonably adequate protection, for the jolt caused by a motorist hitting one of the raised buttons is sufficient to cause him to come to a quick stop. On the other hand, where speeds are fairly high, contact with an obstruction raised some five or six inches from the pavement probably would cause a vehicle to be thrown sharply to one side or catapulted into the protected area. It is also possible for a vehicle to cut into the side of the safety zone without encountering any of the buttons.

BUTTON-TYPE SAFETY ZONE, SPRING STREET, LOS ANGELES
White Guide Line and Red Reflector Buttons

That this type of zone is unsuited for high-speed streets is shown by the fact that in Kansas City, within one month, 4 people were killed and 17 injured in two accidents occurring at button zones. Both accidents were caused by intoxicated drivers. It is believed that, had more substantial protection been provided, these serious consequences could have been avoided. It is true that, if the obstruction had been more substantial, the cars and drivers would doubtless have been more seriously injured; but in that case the injured parties would have been those responsible for the accident, not innocent pedestrians.

The button-type zone used in Los Angeles is illustrated. The only illumination at night is gained from red reflectors placed in three of the five end buttons. The extended white paint line calls the motorist's attention to the approaching obstruction.

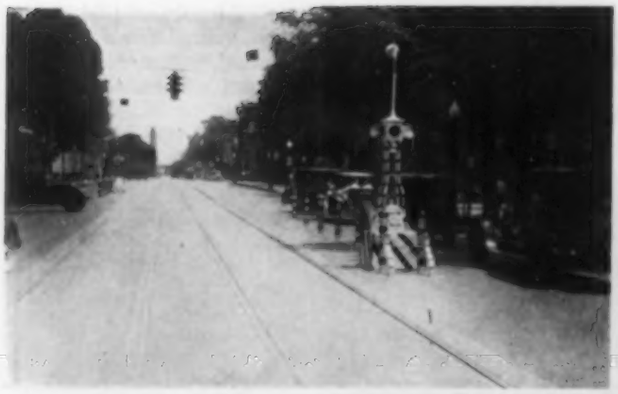
It has been pointed out that on high-speed arteries a more substantial type of protection should be provided at loading points for street cars. One of the earliest types of safety zone used in this country was an area enclosed by steel posts imbedded in the pavement. This type of zone offers definite protection to the street-car passenger but is very hazardous to the motorist unless it is adequately illuminated at night. It was soon found that motorists would hit anything placed in the roadway, regardless of numerous precautionary measures. Sleeves were therefore made in the pavement and the steel posts slipped into them, thus making easy the replacement of bent or broken posts.

Three different types of post zones are illustrated. In Cleveland, a special red flasher and floodlight is used to warn motorists at night. On high-speed streets, the city of Columbus, Ohio, uses a zone marked off by striped posts that are striking if not esthetic in appearance. The end buttress is protected by two bent H-beams imbedded in the pavement in front of two sturdy steel posts. The lighting equipment consists of red flashing beacons and two floodlights, one illuminating the concrete buttress and the other focused on the protected area, bringing waiting passengers into sharp relief. In Detroit a covered post-zone is used on Jefferson Avenue at express stops. In addition there is a pavement warning, "Drive to Right."

One of the objections to the post type of zone is that it is disagreeable to stand in during rainy or slushy weather because of the splash caused by passing vehicles and the spray sent out by street-car wheels. This objection may be partially overcome by the erection of a splash plate along the outside of the posts, but in order to make it unnecessary for pedestrians to stand on the wet street a raised platform must be constructed.

RAISED PLATFORM ZONE

The advantages of a safety island in the form of a raised platform are that an automobile can climb the raised edge of the zone only with difficulty and that pedestrians



In Columbus, Ohio

On Jefferson Avenue, Detroit

In Cleveland, Ohio
POST-PROTECTED SAFETY ZONES

are more or less removed from the rain and snow on the pavement. These zones, like the post zones, have the disadvantage of being a hazardous obstruction to vehicles; and they must necessarily occupy a fairly large amount of street space. Some of the more recent developments in the design of platform safety zones are illustrated. Cincinnati uses a platform protected at the end by a semicircle of car rails imbedded in the pavement. A special red flasher and a reflector shield are used for protection at night. On some of the outlying streets the platform is floodlighted. Additional warning is provided by means of steel markers placed in the form of an arrow extending about 75 ft. in the direction from which the traffic comes.

On a few of the islands on Michigan Avenue, in Detroit, a massive concrete buttress with a beveled edge is used. This edge is provided in an attempt to turn cars away from the buttress and thus prevent more serious collisions.

Another type of zone used in Detroit is of all-steel construction with a grilled floor. Some of the advantages attributed to it are ease of cleaning, reasonable cost, ease of removal during parades or when change of location is desired, restriction of exit and entrance to one point and that at the crosswalk, and the skewed deflector plate at the end. A floodlight illuminates the end of the zone, and for added protection a reflector is placed near the bottom of the post.

A new-type platform is being installed on some of the more dangerous loading points on high-speed arteries in Kansas City. The prow is so designed that vehicles striking it will veer off to the side and not collide violently with the end wall. Reflector buttons have been placed at the tip of the prow and in the wall. The entire loading island is illuminated with floodlights at night.

THE MOTORIST SHOULD ALSO BE CONSIDERED

Thus far I have discussed only types of safety islands that are now in use in several of our largest cities. Each has particular advantages under certain conditions; it cannot be definitely said that one is better or more efficient than another. Usually a safety island is constructed with the sole purpose of protecting the pedestrian or street-car passenger. Nearly every one of the

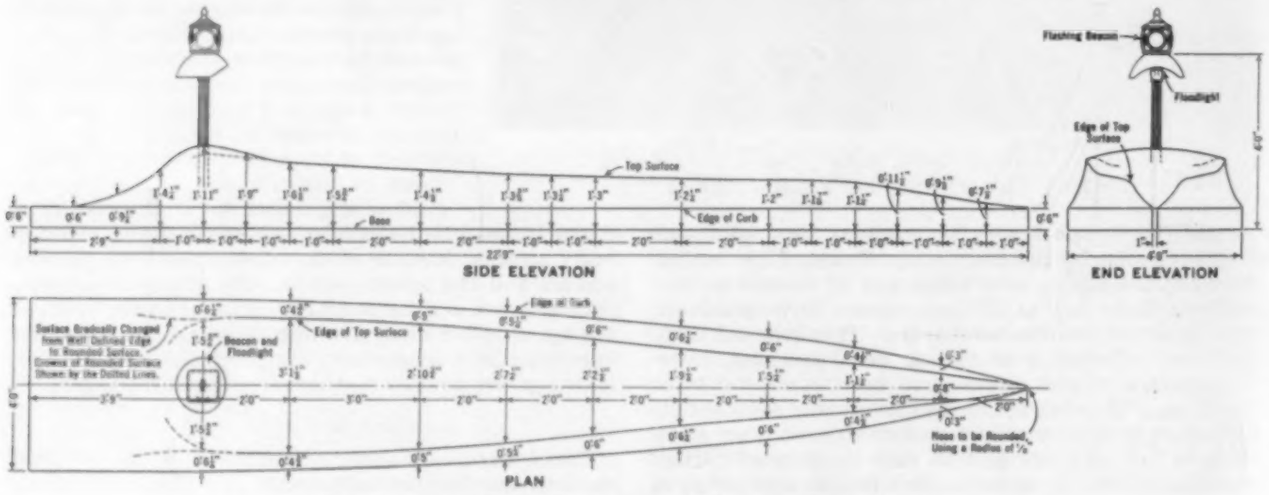

Flashing Beacon
Floodlight
Edge of Top Surface
Top Surface
Edge of Curb
Base
SIDE ELEVATION
END ELEVATION
Surface Gradually Changed from Well Defined Edge to Rounded Surface. Crowns of Rounded Surface Shown by the Dotted Lines.
Beacon and Floodlight
Edge of Top Surface
Edge of Curb
Nose to be Rounded, Using a Radius of 1/2
PLAN

FIG. 1. STREAM-LINED PROTECTOR FOR ROADWAY OBSTRUCTIONS

Plow-Head Zone, Detroit

All-Steel Island, Detroit

Post-Protected Zone, Cincinnati

PLATFORM-TYPE SAFETY ISLANDS WITH END BUTTRESSES

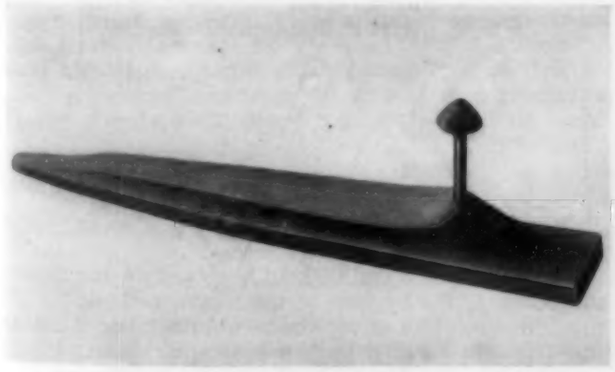
types discussed, except the button zone, will do this and do it well. But what happens to the motorist who strikes one of these sturdy end buttresses? Regardless of their purpose, when such obstructions are placed within the limits of a traveled roadway, some measures should be taken for the protection of motorists using that roadway.

It seems to be true that if safety islands are to be effective in protecting pedestrians, they must be hazardous to vehicles. Yet various attempts have been made to meet this difficulty. A few islands have been designed with a prow which will tend harmlessly to throw off any vehicle that may strike it. A protector for roadway obstructions, designed by Dr. Miller McClintock, Director of the Erskine Bureau at Harvard University, is not only highly efficient but also graceful in appearance. The dimensional drawing, Fig. 1, will indicate the theory on which it is designed. The design, with its sharp pointed tip, is such that if a wheel strikes either side of the prow the vehicle will be turned away, and a vehicle straddling the prow will be brought to a stop by the friction of its front axle sliding along the sloping ridge.

The rate of slope along the ridge of the prow will vary for different protectors according to their use and the average speed of the vehicles on the thoroughfare. It would be desirable to make speed checks for streets on which protectors are to be located and from the average speed found to design a prow of the proper length and slope to stop vehicles traveling at that speed. In determining the required slope for a given stopping distance it should be kept in mind that the frictional resistance between steel and concrete is decreased when the materials are wet. Because of lessened visibility, it is in damp or rainy weather that a large share of the collisions with roadway obstructions occur.

Illumination is provided by means of a floodlight placed in the post near the rear of the prow. A flashing beacon is also placed on this post and a red light is recessed into the tip of the prow. The design shown in Fig. 1 is a protector for obstructions, including safety islands, but does not include the safety island itself.

Only a few of the many different types of safety islands being used in various cities have been discussed in this article; there are many others equally interesting and effective. With as many designs as there are men in charge of traffic regulation, there are bound to be many different types of islands. As each is tried and its good and bad points determined, safety islands will evolve into standard types, which, for given conditions, will approach the ideal. The ideal zone would absolutely protect the pedestrian, would cause little if any damage to a vehicle that might hit it, would be inexpensive, and would occupy a minimum of roadway space.



MODEL OF STREAM-LINED PROTECTOR SHOWN IN FIG. 1
Designed by Dr. Miller McClintock, of Harvard University

NEW-TYPE PROTECTOR USED IN KANSAS CITY
At Dangerous Loading Points on High-Speed Arteries

Nomographic Chart for Steel Tapes

Elimination of Corrections to Tape Measurements Made Possible by Determination of Tension of Accuracy

By C. D. Shepard

Bureau of Standards, Washington, D.C.

When a steel tape is used by a surveyor in the field, the laboratory conditions of test, especially temperature, cannot be easily duplicated. Although invar tapes, which have a coefficient of expansion about one-tenth that of steel, have helped to solve the temperature problem in some special cases, their greater cost and the special care with which they must be handled prohibit their taking the place of ordinary steel tapes in general use. A number of organizations, both public and private, have studied the problem of determining the tension that should be applied to a steel tape to compensate for all the varying conditions of field surveys. However, it has remained for the Bureau of Standards to develop the mathematical formula with usable charts enabling the surveyor to find readily the "tension of accuracy" for ordinary steel tapes. In this article, publication of which is approved by the Director of the Bureau of Standards of the U.S. Department of Commerce, Mr. Shepard gives experimental verification of the formula and includes information as to the several constants to be used in it.

AT THE National Bureau of Standards the standard test for a 100-ft. steel surveyor's tape is made with the tape supported horizontally throughout its length at room temperature under a tension of 10 lb. For tapes over 100 ft. in length, a tension of 20 lb. is used. From the length thus observed, the length at 68 deg. fahr. (20 deg. cent.) is computed, assuming a coefficient of thermal expansion of 0.000,006,45 per deg. fahr. (0.000,011,6 per deg. cent.). Other tests are made when requested.

Tapes may be used in the field either under the tension at which they were standardized in the laboratory or under that which will give their nominal length, that is, the tension of accuracy. In the first case, it is nearly always necessary to make corrections for deviations from the standard temperature or for changes in the method of support; in the second case, no corrections need be made. Using the ordinary methods of computation, it is not easy to calculate the tension of accuracy of a tape at a given temperature when the tape is supported at equidistant points. An attempt to remedy this condition has been made by the Bureau of Standards.

FUNDAMENTAL FORMULA IN COMMON USE

The formula for the length of a tape held under tension and supported at equidistant points at the same height is to be found in any standard textbook on surveying and is given with sufficient accuracy as follows:

$$L = L'\left[1 + \frac{P}{AE} + \alpha\,(t - t_0) - \frac{1}{24}\left(\frac{wd}{P}\right)^2\right] \quad . \quad [1]$$

in which

- L' = distance between terminal graduations when the tape is lying flat, under no tension, and at the standard temperature. This condition is actually never realized
- L = distance between terminal graduations on the tape under the given conditions
- P = tension on tape
- A = cross-sectional area of tape
- E = Young's modulus of elasticity of tape
- α = coefficient of thermal expansion of tape
- t = temperature
- t_0 = standard temperature
- w = weight of tape per unit length
- d = span, or distance between equidistant points of support

These should be in consistent units: for example, all lengths in inches, weights and tensions in pounds, Young's modulus in pounds per square inch, temperatures in degrees fahrenheit, and expansion in inches per inch per 1 deg. fahr.

In this equation, $\frac{L'P}{AE}$ is the stretch under tension; $L'\ \alpha(t - t_0)$, the elongation under the temperature change; and $\frac{L'}{24}\left(\frac{wd}{P}\right)^2$, the sag correction calculated under the assumption that a parabola is a sufficiently close approximation to the actual catenary.

In Table I there is shown the computed difference in length calculated by the sag formula, for 100-ft. tapes under tensions of 10, 15, 20, and 25 lb., when supported throughout and when supported at 25, 50, and 100-ft. intervals. Since all these corrections are small they may be treated as independently additive. Designating the condition of calibration by the subscript *0*, and field conditions by the subscript *1*, the tension of accuracy is determined by the equation, $L_1 = L_0$ = the nominal length of the tape.

Then

$$L'\left[1 + \frac{P_1}{AE} + \alpha(t_1 - t_0) - \frac{1}{24}\left(\frac{wd}{P_1}\right)^2\right] = L'\left[1 + \frac{P_0}{AE}\right] \quad . \quad [2]$$

where

- P_0 = tension of accuracy of the tape at standard temperature, t_0, when supported throughout, and
- P_1 = tension of accuracy of the tape at temperature t_1, when supported at equidistant points at a distance d apart.

Dividing by L_1 and rearranging, we obtain the cubic equation,

$$P_1^3 - P_s P_1^2 - K = 0 \quad . \quad . \quad . \quad . \quad . \quad [3]$$

where $K = \frac{AEw^2d^2}{24}$ and $P_s = P_0 - AE\alpha(t_1 - t_0)$. Here P_s is the tension of accuracy of the tape when supported throughout at temperature t_1.

This Equation 3 can be readily solved for the tension of accuracy, P_1, by any of the usual methods for the numerical solution of algebraic equations but it can be more readily handled by a nomographic chart, as suggested to me by Dr. L. B. Tuckerman. The equation is in Soreau's canonical form IV_0 (*Nomographie* by Soreau, Paris, 1921) permitting parallel linear scales of

$\frac{AEw^2d^2}{24}$ and $[P_0 - AE\alpha(t_1 - t_0)]$ with a curved functional scale of P_1. The multiplication of $AE\alpha$ by $(t_1 - t_0)$ permits of two parallel linear scales of $AE\alpha$ and $[AE\alpha(t_1 - t_0)]$, with an inclined projective scale of $(t_1 - t_0)$. The subtraction of $[AE\alpha(t_1 - t_0)]$ from P_0 permits of three parallel linear scales of $[AE\alpha(t_1 - t_0)]$, P_0, and $[P_0 - AE\alpha(t_1 - t_0)]$. Since both the scales of $[AE\alpha(t_1 - t_0)]$ and $[P_0 - AE\alpha(t_1 - t_0)]$ are linear, the three nomograms may readily be combined in one, as shown in Fig. 1.

VERIFICATION OF THE TENSION OF ACCURACY FORMULA

Experimental determinations of the tension of accuracy were then made, using a group of 45 tapes, 100

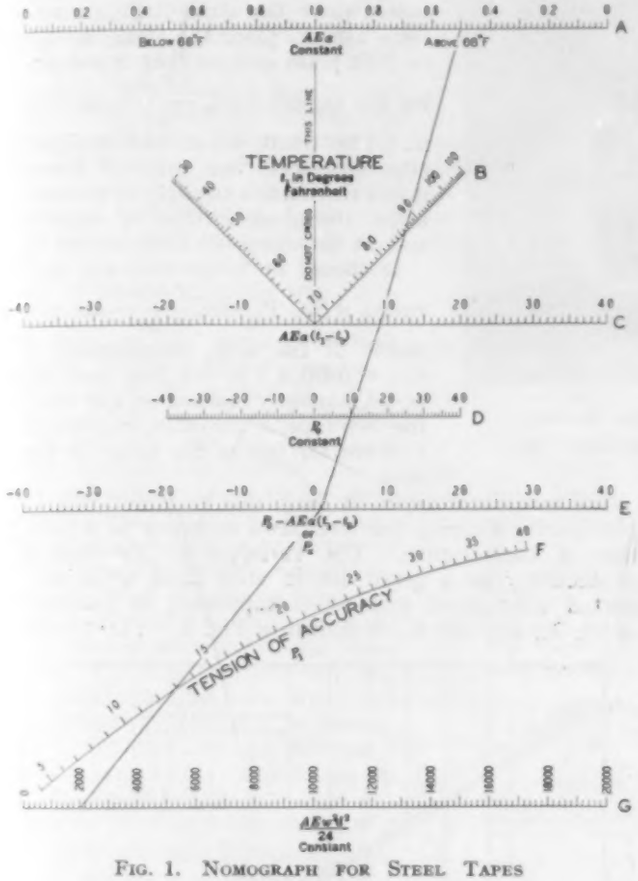
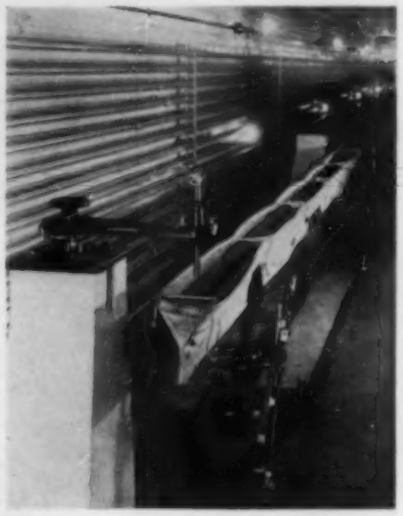


FIG. 1. NOMOGRAPH FOR STEEL TAPES

ft. in length, which were being studied for some of their physical characteristics. The tension of accuracy was determined experimentally for each of the 45 tapes, when supported at the 0 and 100-ft. points, at four or more temperatures between 50 and 95 deg. fahr. In making these observations, special precautions were taken to obtain an accuracy of within 0.1 lb. The observed values of tension of accuracy were found to agree with the computed values to between 0.1 and 0.3 lb. In Table II are shown the results of the test on five typical tapes. Tape E was graduated on babbitt metal at every foot, and at every one-tenth foot in the terminal foot at each end of the tape. The babbitt metal is considered as being uniformly distributed along the tape.



UNITED STATES STANDARD 5-METER BAR PACKED IN ICE
Used to Build Up a Length of 50 Meters for Testing Invar Tapes

CONSTANTS TO BE USED IN THE FORMULA

In this investigation, the generally assumed value of the thermal coefficient of expansion of steel tapes was checked as being applicable to these 45 tapes, some of which were made of ordinary tape steel and others of stainless steel. The tapes having the maximum deviation from the adopted value of 0.000,006,45 per deg. fahr. (0.000,011,6 per deg. cent.) have coefficients so near this that an error of less than 0.0005 ft. in 100 ft. for a change in temperature of 30 deg. fahr. is made if this nominal value is used instead of the experimentally determined value.

TABLE II. COMPARISON OF COMPUTED AND OBSERVED VALUES OF TENSION OF ACCURACY; FOR FIVE TYPICAL 100-FT. TAPES

TAPE DESIGNATION	NOMINAL CROSS SECTION IN INCHES	WEIGHT PER FOOT OF TAPE IN POUNDS	TENSION OF ACCURACY AT 68 DEG. FAHR. WHEN SUPPORTED AT 0 AND 100-FT. POINTS; IN POUNDS	
			COMPUTED	OBSERVED
A	1/4 by 0.006	0.0042	11.2	11.3
B	1/4 by 0.020	0.0079	15.9	16.0
C	3/8 by 0.007	0.0087	17.7	17.7
D	1/2 by 0.007	0.0108	20.1	20.2
E	5/16 by 0.016	0.0177	26.4	26.2

Young's modulus of elasticity may be assumed as 28.0×10^6 lb. per sq. in. This is the mean value that was experimentally determined in this investigation. It is in agreement with the results of other tests on tapes at the Bureau of Standards. For all practical purposes this mean value may be used for any steel tape, because

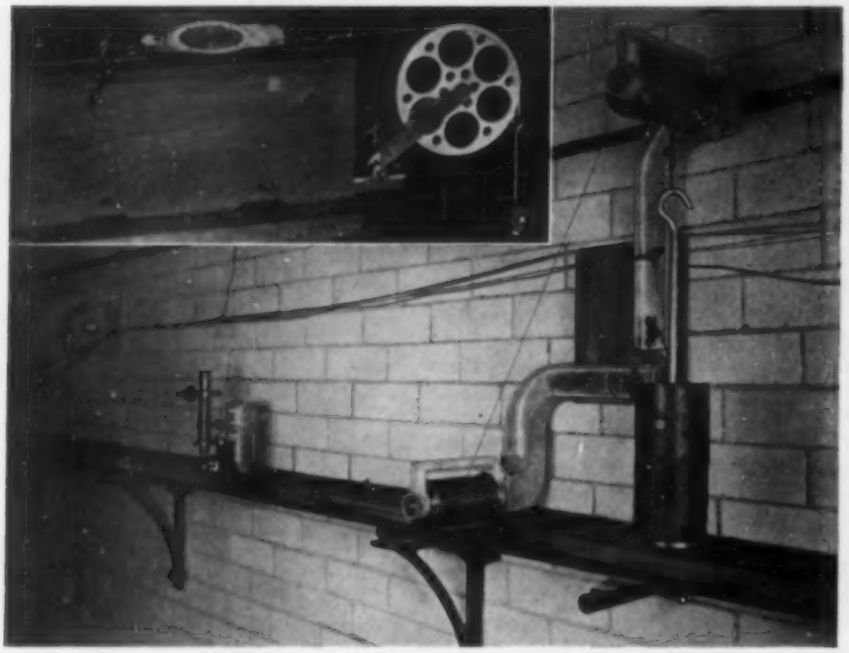
TABLE I. CORRECTIONS FOR SAG FOR 100-FT. TAPES, IN FEET

To Be Subtracted from the Length of the Tape Supported Throughout at the Same Tension

WEIGHT PER FOOT OF TAPE IN POUNDS	SUPPORTED AT 0, 25, 50, 75, AND 100-FT. POINTS; TENSION IN POUNDS				SUPPORTED AT 0, 50, AND 100-FT. POINTS; TENSION IN POUNDS				SUPPORTED AT 0 AND 100-FT. POINTS; TENSION IN POUNDS			
	10	15	20	25	10	15	20	25	10	15	20	25
0.0040	0.000	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.007	0.003	0.002	0.001
0.0060	0.001	0.000	0.000	0.000	0.004	0.002	0.001	0.001	0.015	0.007	0.004	0.002
0.0080	0.002	0.001	0.000	0.000	0.007	0.003	0.002	0.001	0.027	0.012	0.007	0.004
0.0100	0.003	0.001	0.001	0.000	0.010	0.005	0.003	0.002	0.042	0.019	0.010	0.007
0.0120	0.004	0.002	0.001	0.001	0.015	0.007	0.004	0.002	0.060	0.027	0.015	0.010
0.0140	0.005	0.002	0.001	0.001	0.020	0.009	0.005	0.003	0.082	0.036	0.020	0.013
0.0180	0.008	0.004	0.002	0.001	0.034	0.015	0.008	0.005	0.135	0.060	0.034	0.022

the experiments just referred to indicate that the maximum error introduced by this assumption in the case of a 100-ft. tape with a change in tension of 15 lb. would be only 0.0005 ft. approximately.

Because of the difficulty, in many cases, of obtaining a sufficiently precise value for the cross-sectional area, when using this chart it is advisable to determine the value of the product AE. Since AE equals $\frac{(P_2 - P_1)L}{\Delta L}$, where ΔL is the change in the length L when the tension is changed from P_1 to P_2, this value is found by measuring the change in length of the tape when supported throughout at constant temperature at two tensions differing by 15 lb. or more. The sag correction was checked experimentally and found to be correct to within 0.001 ft. for the purpose of this "tension of accuracy" formula.



APPARATUS FOR APPLYING TENSION TO TAPES BY CALIBRATED WEIGHTS
Insert: Testing a Spring Balance with Calibrated Weights for Field Use

The next step was to construct a nomographic chart (Fig. 1), which would be applicable to any of the 45 tapes tested in these experiments. Nearly all the types and sizes of 100-ft. steel tapes manufactured and used in the United States were represented in the tests. The chart is applicable to tapes of any length within the range of the scales of the nomogram. Other nomograms may be drawn for tapes whose constants do not come within the scales on this one.

Referring to the nomogram in Fig. 1, the values for the 45 tapes of $AE\alpha$, on the axis marked A, varied from 0.3 to 0.9. The inclined projective scale of $(t_1 - t_0)$, on axis B, is calibrated in terms of the observed temperature, t_1, from 30 to 110 deg. fahr. The numerical value of the product $AE\alpha$ and $(t_1 - t_0)$ is not necessary, and axis C is a dummy axis. Although the value P_0, on axis D, is generally positive, for the sake of uniformity the graduations are shown in units from -40 to $+40$ lb. Theoretically, for purposes of computation, the value of P_0 may be negative for some tapes. Axis E is a dummy axis, but in case the value P_s is known at the observed temperature, t_1, this axis is calibrated in pounds from -40 to $+40$. The axis G is calibrated in units between 0 and 20,000, and the tension of accuracy on the curve F is given in units between 4 and 40 lb. Within these units are found the approximate usable values of the tension of accuracy for 100-ft. tapes.

To find the tension of accuracy for a tape, place a straight-edge on the point representing the constant, $AE\alpha$, on axis A, and on the point representing the observed temperature, t_1, on the inclined scale B. Note the intersection of the straight-edge with the dummy axis C; then place the straight-edge on this intersection and on the point representing the value P_0, the tension at which the tape has its nominal length when supported throughout at standard temperature on axis D. After determining the point where the straight-edge intersects axis E, place the straight-edge on this point and on that representing the sag constant, $\frac{AEw^2d^2}{24}$, on axis G. The point where the straight-edge intersects the curve F determines the tension to apply to the tape under the given method of support and at the observed temperature t_1.

It should be noted that the constants $AE\alpha$, P_0, and $\frac{AEw^2d^2}{24}$ are constants of the tape, independent of the conditions of its use, and can be permanently marked on the chart for each tape, in the office, in preparation for the use of the chart in the field.

For individual tapes, it may also be convenient to plot curves showing the tension of accuracy as a function of temperature. The variation of the tension of accuracy for a given 100-ft. steel tape, when supported throughout and when supported at intervals of 25, 50, and 100 ft., is shown in Fig. 2. The tension of accuracy of a tape supported throughout, when plotted against temperature, gives a straight line. This line represents the variable value P_s, as given in Equation 3 and Fig. 1. On the curve for this tape, when supported at the 0 and 100-ft. points, the several locations of the circles show the observed values with respect to the curve of calculated values, and verify the accuracy of the curve.

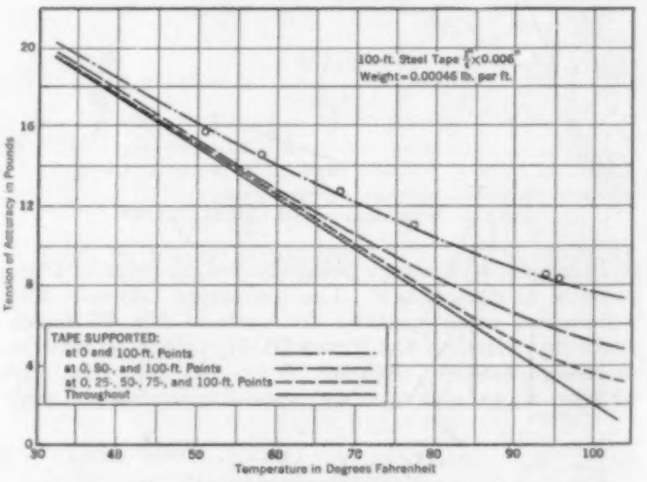

100-ft. Steel Tape ¼×0.006"
Weight = 0.00046 lb. per ft.
Tension of Accuracy in Pounds
Temperature in Degrees Fahrenheit
TAPE SUPPORTED:
at 0 and 100-ft. Points
at 0, 50-, and 100-ft. Points
at 0, 25-, 50-, 75-, and 100-ft. Points
Throughout

FIG. 2. TENSION OF ACCURACY CURVE FOR A GIVEN TAPE

New Types of Box Piles

Experience in Using Square Steel Sections for Underpinning on New York Subways

By JOHN L. WASHBOURNE

JUNIOR AMERICAN SOCIETY OF CIVIL ENGINEERS

CIVIL ENGINEER, HART AND EARLY COMPANY, INC., NEW YORK

IN the solution of a rather novel problem of underpinning and shoring, two modifications of the more or less usual methods were successfully used on a building abutting on the subway right-of-way. First, the weakened structure was strengthened by a series of bonds, anchors, and ties so that the building itself would act as a unit; and second, a method was developed of introducing sufficient lateral stiffness, or beam action, into a pile so that it would help retain the exposed side bank as well as the building itself. This dual action was obtained by combining short pairs of channels and plates into a box filled with reinforced concrete. Mr. Washbourne's account of the ingenious procedure devised for this situation will make interesting reading for foundation engineers.

AS a preliminary step in the excavation of a section of New York's subway system, it was necessary to permanently underpin all adjacent buildings. One building in particular presented difficulties, which were due to: (1) its proximity to the excavation line of the subway; (2) the type of soil on which it was founded and through which the subway was to be built; and (3) its rather advanced age and doubtful condition.

As shown in Fig. 1, some parts of each of two building lines were coincident with the subway net lines. The distance from the street surface to the subgrade was about 50 ft., with groundwater at a depth of 20 ft., or 7 ft. above mean high water. Coarse sand was found to a depth of 25 ft., gradually changing into Manhattan quicksand at a depth of about 40 ft.

As nearly as can be ascertained, the building under consideration was erected about 1860. As the adjoining property was to be demolished, thus taking away existing lateral support, the indications were that the structure could be underpinned only after considerable strengthening. Because of many changes in floor beams and stair wells, the walls were pocked with voids and beam holes. The original party wall was not bonded to the later walls and consequently, on removal of the adjoining building, became more of a hazard than a help. Lack of bearing for the floor beams not only endangered the floor itself, but left the side walls without lateral support. This condition was realized by the Board of Transportation and the Building Department of New York City; therefore orders were given that the building be put in a safe condition.

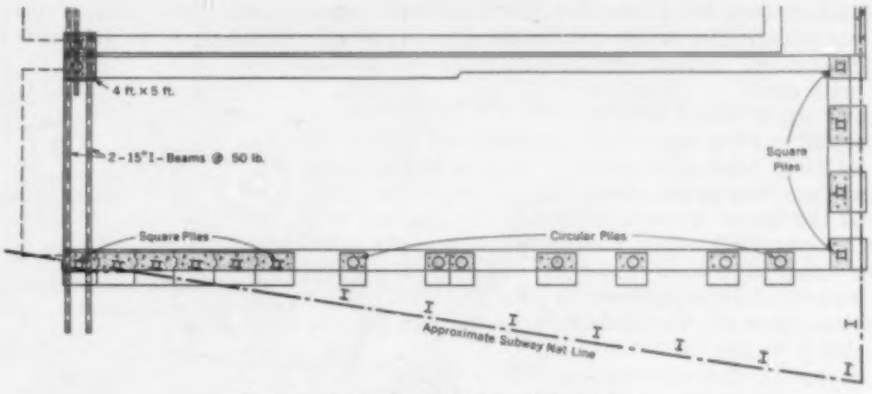


FIG. 1. PLOT PLAN OF THE BUILDING
Showing Its Relation to the Subway and to the Underpinning Piles

The strengthening of this structure was accomplished in two steps: first, by bonding the walls and floor beams together, thus increasing the bearing for the floor beams; and, second, by replacing the old loose rubble foundation with concrete.

TYING FLOOR BEAMS TO SIDE WALLS

In the side walls, pockets were cut exposing the ends of every second or third floor beam. By means of a special angle brace and bit, two $^3/_4$-in. holes were bored through these beams on 6 to 8-in. centers, starting 6 in. from the end of the floor beam (Fig. 2). A $^1/_4$-in. by 3-in. U-strap was then secured to the end of the beam by two $^5/_8$-in. bolts through these holes. The base of each strap was set flush with the outside of the wall. A machine bolt was slipped into a hole at the outer end of the U-strap and the pocket in the wall was grouted solid with the exception of the outside 4 in., which was filled in with brick.

In the rear, since the floor beams paralleled the walls, a different procedure had to be adopted, as shown in Fig. 2, Section A-A. Through 8 by 8-in. holes cut in the wall, $1^1/_4$-in. holes were bored through the floor beams. Nearest the side walls, the first floor beam only was bored; through the next adjoining holes two floor beams were bored; then three, and four beams. Toggle bolts, 1 in. in diameter, were then inserted and pulled taut; and the wall pockets were bricked in so that the threaded end of the bolt protruded outside the wall about 2 in., as did the bolts through the side walls. A great amount of stiffness was added to the floor beams by the diagonal flooring. The protruding ends of the bolts were connected with a $^1/_4$ by 3-in. strap iron drilled to fit them, and then tightened by nuts (Fig. 2). This procedure was followed out at each floor level, thus unifying the building by using the floor beams as cross ties to prevent the walls from bulging and increasing the bearing of each beam. It may be noted that the holes in the walls were cut in such a way that, when grouted, the grout would act as a wedge or plug and thus help resist any tendency of the walls to spread.

PILES TO DEVELOP BEAM STRENGTH

When the structure had been thus strengthened, it was considered ready for underpinning. The high groundwater level prevented construction of a retaining wall or deep piers by the usual pit method; and cylindrical friction piles designed to hold the building

would not have developed the beam strength necessary to retain the soil underneath, where the subway net line and the building line were practically coincident. Instead, concrete-filled sectional box piles made of steel were jacked into place where the building line was from 0 to 24 in. away from the net line, and cylindrical piles were used elsewhere (Fig. 1). These piles averaged about 52 ft. in length. The box piles, spaced 5 ft. from center to center, were designed to carry a 30-ton load to at least 5 ft. below subgrade, and to withstand an average lateral pressure of 2,500 lb. per lin. ft. over a 15-ft. vertical span. To comply with the building code, the piles had to withstand a test load of 150 per cent of the desired working load.

As shown in Fig. 3, the box piles were made up of two 12-in. channels and two $^{5}/_{16}$-in. plates. Each pair of channels was bolted to each pair of plates, the horizontal joints being staggered 3 ft. The plates and channels were in themselves reversible because the bolt spacing was symmetrical about both center lines. This made the erection of the piles simple.

The design of the box pile as a beam was approached from the safe assumption that the concrete beam constituting the core, and the steel shell, computed as a box girder, acted independently. The reinforced concrete beam, 9 by 11 in., contributed about one-fifth of the maximum resisting moment. The remaining four-fifths came from the steel shell computed as a box girder. For other localities the sizes and weights of the channels, plates, and bolts could be varied to suit any practical loading conditions over spans up to 25 ft. Reinforcing angles also may be bolted to the inside corners of the box shell across the channel joints to take the horizontal shear. These piles showed no deficiency in the field; they supported the side pressure over spans greater than the assumed 15 ft. with no visible deflection.

SECTION OF OLD RUBBLE FOUNDATION REMOVED
Box Pile in Place Ready for New Concrete Foundation

ASSEMBLING THE PILES

Box pits, 4 by 5 ft., were dug for every third pile to approximately 2 ft. below the footings of the building and the old footing was removed, thus giving ample headroom—about 8 ft.—in which to jack the piles. A steel plate was dry-packed against the bottom of the good section of wall above and centered on the proposed pile.

A starting section of pile, consisting of two 6-ft. sections of channel and two 3-ft. plates with the cutting edges beveled and the corners vertically welded for a length of 6 in., was then placed in position, surmounted by a 20-in. hydraulic ram $4^{1}/_{2}$ in. in diameter. Gaskets, made of two-ply waterproofing fabric, were placed at each bolt line to ensure a watertight fit. The pile starter was pushed into the ground using very little pressure. When the pile had been jacked down so that the tops of the 3-ft. starting plates were just above the bottom of the pit, two standard 6-ft. plates were bolted to the protruding ends and the jacking was continued, plates and channels being added alternately as needed, with simultaneous mucking.

DRIVING AND MUCKING PROCEDURE

As a general rule, the box piles could be jacked from 6 to 8 ft. into the soil before the hydraulic pressure on the gage would reach 5,500 lb. per sq. in., or a total of 44 tons, the limit taken as the maximum safe reaction that the wall would sustain. At this depth of from 6 to 8 ft., the soil inside the hollow box pile had built up this resistance, which was relieved by the jet method. A water hose to which was attached a jet point was lowered into the pile and wired so that the jet could not come nearer than 18 in. from the bottom of the pile, thus preventing any scouring action. The intake hose of the suction pump was then placed in the pile so that the foot valve remained approximately 24 in. below the top section. This set location kept a constant head of water against the soil at the base of the pile, thus counteracting any tendency to "boil" as the pile was excavated below groundwater level. Of course

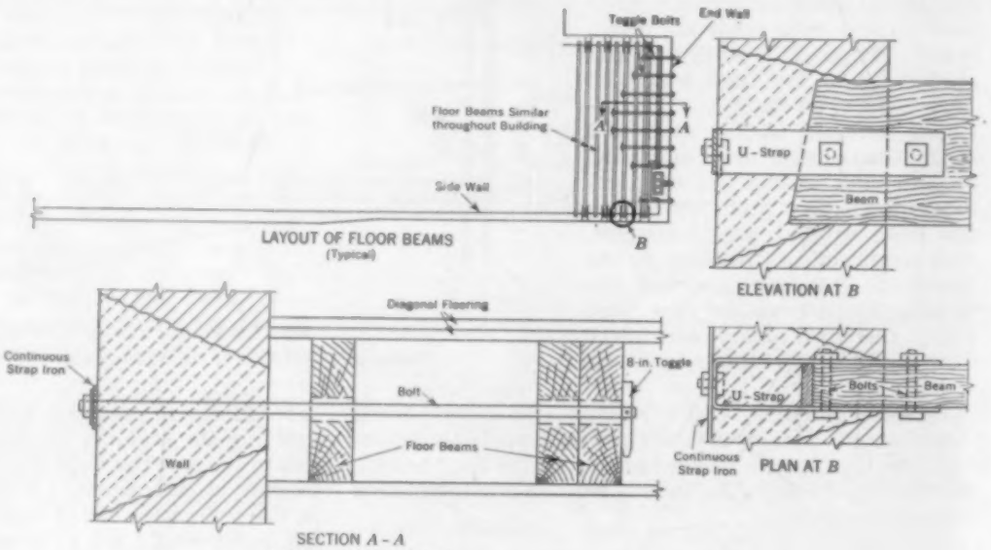


FIG. 2. STRENGTHENING THE WALLS OF THE BUILDING
Details of Bonding to the Floor Beams

the discharge was adjusted to the same rate as the inflow through the jet.

No difficulty was experienced so long as the jet was kept in slight motion by the operator. This prevented the sand from settling in the pile and relieved all resistance, except that of side friction, which was overcome by the rams. Ordinarily, the pressure gage registered about 4,000 lb. per sq. in., except where the clay strata just below the subgrade of the subway were pierced—then the pressure jumped immediately to 5,500 lb. per sq. in. The power had to be turned off and the jet lowered so that it was only 6 in. from the bottom of the pile in order to keep the jacking pressure within safe limits. In order to dislodge certain strata of clay at this lower depth, progress was sometimes slowed down to only 1 in. per hour. Finally the seam was broken through by keeping the pressure constant at its maximum and increasing the water pressure in the jet.

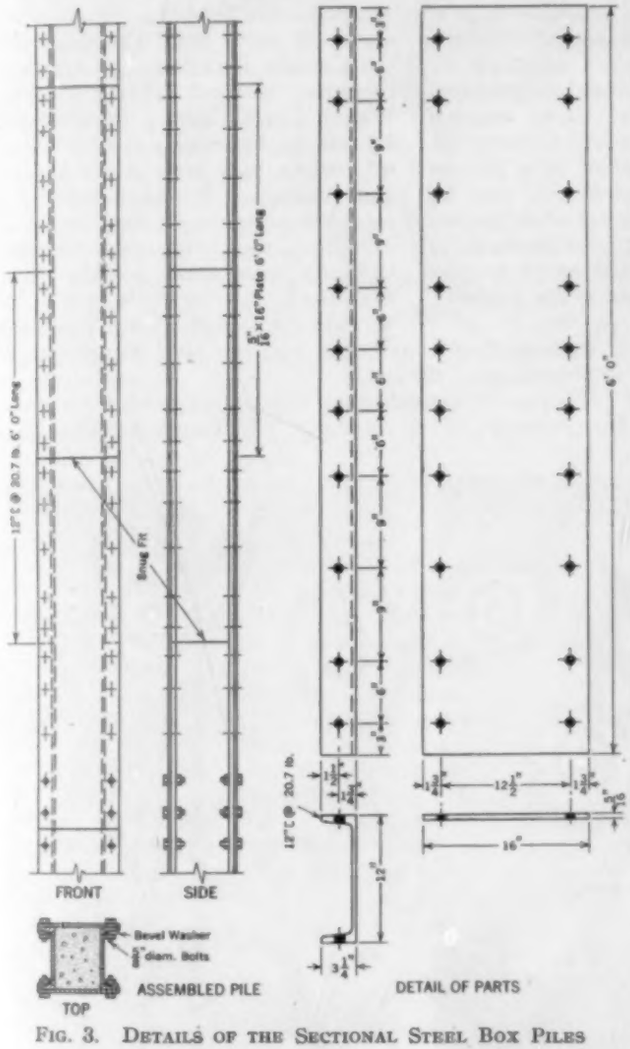
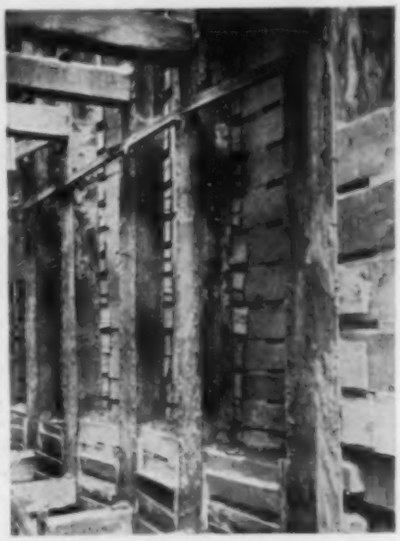


FIG. 3. DETAILS OF THE SECTIONAL STEEL BOX PILES

FOUNDATION CONSOLIDATED AND TESTED

When subgrade was reached, the jet and suction lines were withdrawn and the pile sealed by depositing six or eight half-filled bags of a dry mixture of sand and cement. This seal was tamped into place and left to set for between 24 and 36 hours. After the setting time had elapsed, the pile was pumped dry by a small pneumatic, vertical, centrifugal pump lowered into the pile. Piles 56 ft. long were pumped dry by this machine in a very few minutes.

No leakage at the joints occurred, because of the efficiency of the gaskets. After the required reinforcing rods were set, the concrete was placed by a small bottom-dumping pile bucket.



INTERIOR OF THE EXCAVATED SUBWAY CUT
Showing Square Piles with Sheeting and Braces

Each pile was then fatigue-tested to 75 tons. The required test load was slowly applied by means of hydraulic rams and the settlement due to this load was noted. The load was kept constant for approximately three minutes, and then was slowly released and the rebound noted. During repeated loadings, readings were taken as to settlement and rebound, and this procedure was repeated until the settlement and rebound became equal to or less than $\frac{1}{4}$ in. and $\frac{1}{8}$ in., respectively. For this result an average of 6 or 8 cycles was required. The theory of this method of pile testing is that the so-called bulb of pressure at the point of the pile is greatly enlarged with each cycle, and thus the pile load is distributed over a far greater area. In other words, with each application of pressure, the supporting sand collectively approaches a maximum density until the slight settlement and rebound may be safely ignored.

COMPLETING THE UNDERPINNING

Each jacking crew averaged from 18 to 20 ft. a day through all grades of sand. On reaching subgrade, they placed the seal, removed all gear and equipment, and moved to the next pit, leaving the pile to be taken over by another gang, which pumped it dry and concreted it in between a half and three-quarters of an hour. The testing gang followed, with a field engineer to take such notes as were necessary for computation and to complete the record.

It is of interest that these piles were successfully tested by this fatigue method to as high as 80 tons, although 45 tons was all that was required. This load, sustained for more than ten minutes, is a good test of what a box pile of these dimensions is capable of sustaining in typical Manhattan soft ground.

In the course of the ensuing excavation for the subway, inter-pile sheeting was placed behind the piles to a depth of 20 ft. above subgrade, at which depth the sheeting was moved in behind the front flanges, as shown in the photograph. Subway braces were spaced from 13 to 17 ft. apart, and no deflection was noticed, nor was there any appreciable settlement in the building.

This work was done by the Hart and Early Company, Inc., of 18 East 41st Street, New York, under contract with the Board of Transportation of the City of New York. I was engineer in charge of underpinning for the contractor.

Geodetic Surveys on an African Plantation

A Description of the Methods Used on the Firestone Properties in Liberia

By C. F. Maynard

Member American Society of Civil Engineers

Chief of the Computing Division, U.S. Coast and Geodetic Survey

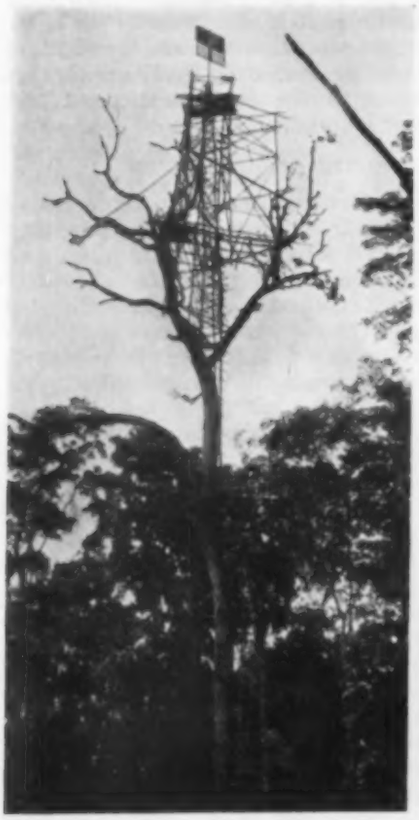
Manila, Philippine Islands

During 1928–1931 Mr. Maynard had charge of planning and executing accurate surveys of two Firestone plantations in Liberia, parts of a million-acre tract leased from the Liberian Government. The technical methods used followed generally those of the U.S. Coast and Geodetic Survey, except that native "boys" supplied the labor and tall trees provided the principal triangulation stations. It is unusual that a survey of such a high degree of accuracy should be adopted in a pioneer country; it was used in this case because the triangulation net would prevent any boundary disputes, and the resulting topographic map would make possible the orderly development of the property.

BETWEEN 1928 and 1931, the Firestone Plantations Company carried on geodetic, boundary, and topographic surveys of its properties in Liberia. The Liberian Government had granted the company a 99-year lease on a million acres, with the stipulation that as soon as areas had been definitely selected for development, surveys should be made of them and the boundaries marked. In view of this fact, it was considered advisable by the company to make accurate surveys of its holdings.

The Firestone properties in Liberia are in two plantations. The larger one, the Du Plantation, is about 50 miles by road from Monrovia and embraces 93,000 acres, of which approximately 50,000 acres have been developed. An arc of the Liberian Boundary Survey triangulation, extending from Monrovia in a northerly direction to the French frontier, straddles the Du Plantation. It was from the line Cryon-Coffee of this scheme that triangulation on the Du was started. At Gedetarbo, the second plantation, approximately 12,000 acres have been developed. Gedetarbo is situated about 20 miles from the coast on the Cavalla River, which forms the boundary between Liberia and the French Ivory Coast. In southern Liberia, in the vicinity of Gedetarbo, no survey had been made, so at this plantation it was necessary to establish a datum. Since, with this exception, the surveys on both plantations were made by the same methods, no descriptions will be given of the Gedetarbo work beyond a statement of the means and methods employed in establishing the datum.

Schemes of second-order triangulation were run over the properties of the company. Whenever possible, they



Station Far, 38 m. Above the Ground

Station Ming, 18 m. High

Station Ton, 27 m. High

Tree-Top Triangulation Stations

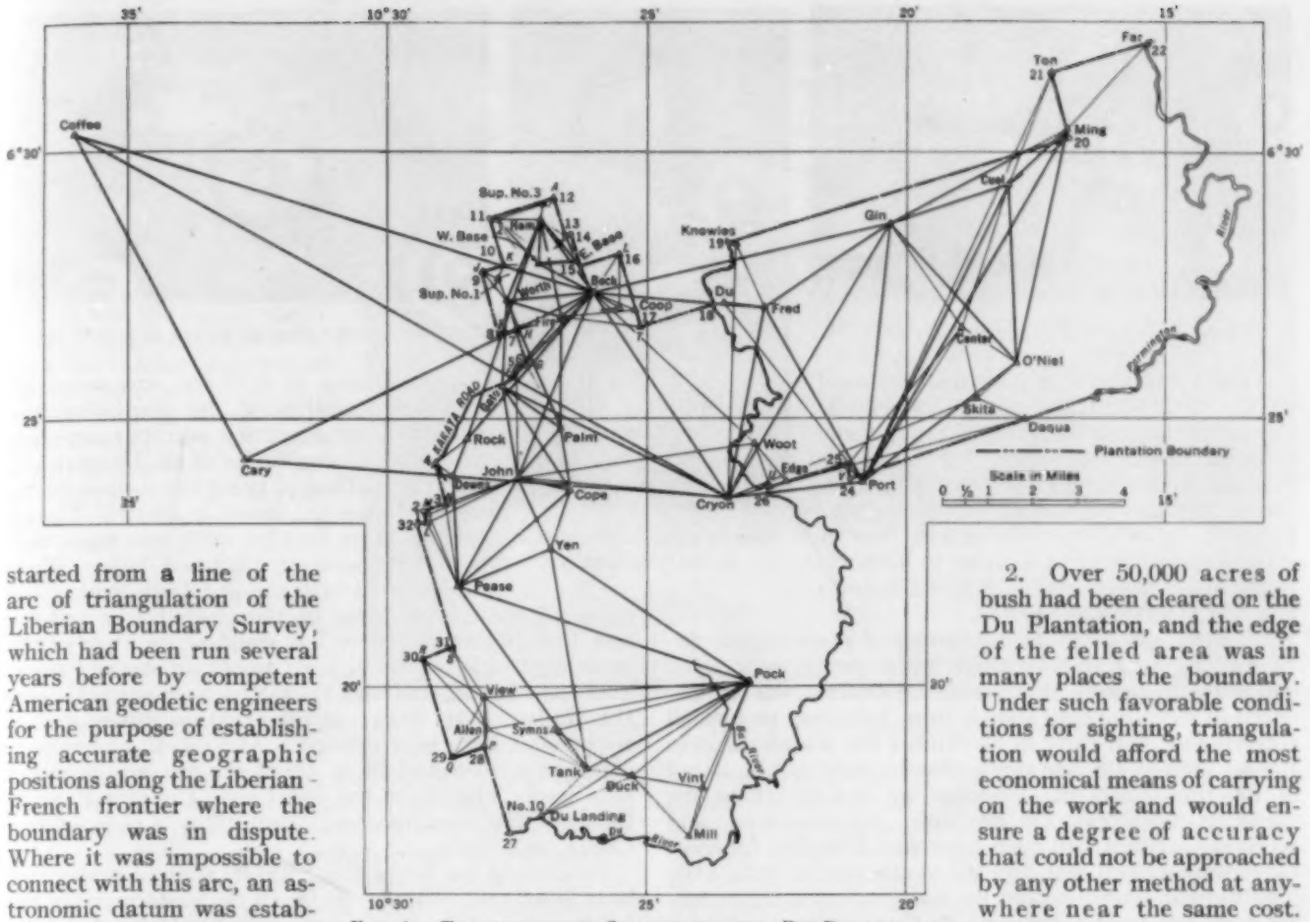


FIG. 1. TRIANGULATION SCHEME OF THE DU PLANTATION
Firestone Project in Liberia

started from a line of the arc of triangulation of the Liberian Boundary Survey, which had been run several years before by competent American geodetic engineers for the purpose of establishing accurate geographic positions along the Liberian - French frontier where the boundary was in dispute. Where it was impossible to connect with this arc, an astronomic datum was established from which to start the work. When possible, all corners were located by triangulation, either by intersections from three stations or by single triangles with all angles observed. Supplementary schemes of second-order work were run wherever corners could not be located directly from the main scheme. Where it was not possible to make the tie by triangulation and any considerable distance had to be covered from the nearest triangulation station to the corner, second-order traverse was used. Plane-table surveys on a scale of 1:12,000 were made of rivers or roads forming the plantation boundary. These surveys were tied in as frequently as possible to second-order control stations. Native reserves within the boundaries of the plantation were mapped by stadia methods and monumented. After the triangulation had been adjusted, a topographic map of the developed area was started on a scale of 1:12,000.

TRIANGULATION SCHEME HAS MANY ADVANTAGES

The advantages to be derived from the use of high-order triangulation are as follows:

1. Since there is only one point on the earth's surface at the intersection of one parallel of latitude and any one meridian of longitude, there can be no dispute as to the meaning of such a geographical definition of the location of a point, even if all the original triangulation station marks used in its determination, together with the map on which its position was originally plotted, have been destroyed. A competent geodetic engineer can reestablish the exact location of an original triangulation station by means of a new system of triangulation connecting with other distant triangulation marks which have not been destroyed.

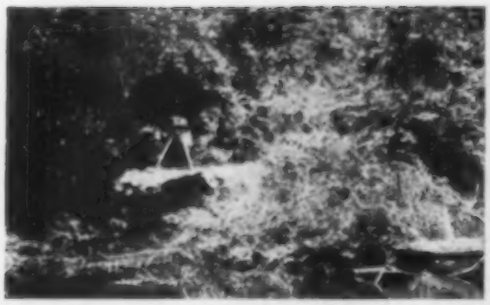
2. Over 50,000 acres of bush had been cleared on the Du Plantation, and the edge of the felled area was in many places the boundary. Under such favorable conditions for sighting, triangulation would afford the most economical means of carrying on the work and would ensure a degree of accuracy that could not be approached by any other method at anywhere near the same cost. Furthermore, it was the only practical method by which a desired connection could be made with the scheme of triangulation of the Liberian Government Boundary Survey.

3. Triangulation would give accurately determined points scattered throughout the plantation, and these would furnish the best control possible for any topographic or other surveys that might be made in the future.

4. A scheme of triangulation once laid down and monumented could easily be extended into adjacent areas that might be developed.

BASE LINES MEASURED

In order to start a scheme of triangulation, the length and azimuth of a line and the latitude and longitude of a point must be known. A base line approximately 2 km. in length was measured at Gedetarbo. This base was measured in two sections of 1,000 and 975 m. in length, respectively. Two standardized 50-m. steel base-line tapes were used—one on the forward and the other on the backward measure. The tapes were supported at the 0, 25, and 50-m. points. A pull of 15 kg. was used. Theremometers were placed at each end of the tapes, at points one meter toward the center from the terminal marks. Both thermometers were read at each new measurement. The forward measure was made in a heavy rain. The tape was snapped before the measurement was made in order to remove the water, and it was wiped off while it was being moved forward to the next station. The weather was clear during the backward measure. During the period in which the base was being measured, the temperature range was very small. A probable error of 1 in 1,970,000 was secured.



PLANE-TABLE SET UP ON THE DU RIVER

NATIVE CANOES USED FOR RIVER TRAVERSES

A BOUNDARY SURVEY PARTY IN THE BUSH

A check base, 1,323 m. long, was measured on the Du Plantation, and the length as computed through the triangulation scheme from the line Cryon-Coffee (Fig. 1) to this base checked within 1 in 29,000. In measuring this base, the same procedure was followed as at Gedetarbo except that it was measured at night in order to keep the temperature range small. A probable error of 1 in 1,890,000 was secured.

All attempts to make astronomical observations between August and November failed owing to weather conditions. During this period no trouble was experienced in receiving time signals from Arlington on a small receiving set, but early in November the transformers in the set burned out and replacements could not be found in Liberia. Early in December we had to return the meridian telescope, chronograph, chronometers, and receiving set that had been borrowed from the Liberian Government, so it was decided to attempt to obtain the longitudinal determination by transporting a chronometer each day from Gedetarbo to Cape Palmas, where a comparison could be made with the time tick which came in from Arlington at 8 a.m. Greenwich Mean Time.

In carrying out this plan, an American watch mounted in gimbals in a wooden carrying case was used. During the daily drive of 20 miles over a very bad road to the cape, the watch was supported on pillows placed in a man's lap. The car was driven slowly, two hours being required for the trip. After the watch was compared with the time tick, it was carried back to Gedetarbo, where it was compared with a siderial clock, which was used to carry the time during the period of observations. Observations for time were made with the meridian telescope on November 16, 24, and 25, 1928, the method used being that in which an azimuth star is included in each half set. This method is fully described in Special Publication No. 14 of the U.S. Coast and Geodetic Survey.

On December 4, a time set and azimuth were obtained with a 7-in. theodolite. This instrument was fitted with 5 vertical hairs, and the method used in determining time was that followed with the meridian telescope. While the time set with this transit was observed merely as a means of determining an azimuth, the time results compared favorably with those obtained with the large instrument.

LATITUDE DETERMINATION BY TALCOTT METHOD

The latitude was determined by the Talcott method, explained in Special Publication No. 14 of the U.S. Coast and Geodetic Survey, ten pairs of readings being taken. A less precise latitude was determined with the 7-in. theodolite by meridian altitudes of north and south stars. The latitude on which all work at Gedetarbo is based is the one determined by the Talcott method. A probable error of 0.47 sec. was obtained.

The boundaries of the plantation, the scheme of triangulation and its connection to the line Cryon-Coffee of the Liberian arc, and the method of tying the corners to the main scheme are shown in Fig. 1. The reconnaissance for this work was made during the season of 1929 and 1930. Work was started from the line Tank-Pock. Because of the configuration of the cleared area and the fact that timber had been left standing on most of the prominent hills, it was difficult to obtain strong figures. The lines Pock-Pease and Pock-Yen were carried above the timber. At Pock, an observation tower and a tripod 9 m. high were erected. At Yen, an observation platform was erected 28 m. above the ground in the top of a tree. The tie to the line Cryon-Coffee was made through the quadrilateral connecting Cryon, Cary, Coffee, and Beck.

East of the Du River about 25,000 acres of timber had been felled and cleared. Between the eastern end of the felled area and the Farmington River, which formed the eastern boundary of the plantation, a block of about 15,000 acres of timber had been left standing. The intersection of the south boundary and the Farmington River was located by second-order traverse from Station Daqua. Corners 20, 21, and 22, all fell in the area covered by heavy bush. They were located by triangulation, the scheme being carried above the forest by means of three towers and a high signal above Corner 20. These towers at Far, Ming, and Ton, which were 38, 18, and 27 m. high, respectively, were made of green timber cut on the location. At Ton the observation platform was supported by a tripod and the instrument by the tree around which the tripod was built. Two legs of the tripod were laid on the ground and framed, and then hoisted into position with a snatch block and rope. After that the third leg was raised and fastened to the bent by cross and diagonal bracing. At Far and Ming, observation platforms were erected in the tops of trees. The instrument support did not come in contact with the platform or the platform scaffold.

MAST SIGNALS ERECTED

Pole signals were used at practically all stations where the instruments could be set up on the ground. The signals consisted of a 16-ft. mast made of 2 by 4-in. timber painted in alternate bands of red and white. The mast carried from 2 to 4 banners at right angles to each other, depending on the length of the lines. The banner frames, which were 6 by 3 ft., were covered with red or white cloth. On the longer lines both red and white were shown. It was found that frequently red could be seen when white did not show, or vice versa. The mast was supported on a bench over the station and held in place by four heavy guy wires.

Materials and tools for pouring a concrete monument at each selected station were carried to the location in petrol tins. A squad of ten "boys" could carry enough tools and material to pour one monument. Eight tins of rock, sand, and cement were enough for the monuments, which were set 3 ft. in the ground. A petrol tin with its top and bottom knocked out was used as a form. An 8-in. galvanized iron bolt was set in the top of the concrete at the time the monument was poured and, when first occupied, was marked with a cross filed in the top.

Observations of horizontal and vertical angles were made with a 7-in. theodolite reading to 10 sec. on the horizontal circle and 20 sec. on the vertical circle. The method of observing was that described in Special Publication No. 145 of the U.S. Coast and Geodetic Survey. The longest line over which observations were made was 16.3 miles in length and the average length of lines in the main scheme was 4 miles. Difficulty was experienced in seeing the signals on the longer lines, due to Sahara Desert dust in the air or to drifting smoke from fires on the thousands of acres that had been cleared by the company. Observations were continued into the wet season. A day or two of heavy rain put out the fires for several days, and it was during these periods of excellent visibility that practically all our observations on the longer lines were secured.

A KPWESSI VILLAGE ALONG THE NORTHERN BOUNDARY

A SURVEY CAMP—LARGE ANT HILL AT LEFT
Station Far Shows Above the Trees

Four boys were used in the observing party. This number could be crowded into a car with the instruments and tools and could easily carry the loads when the car was left behind. One boy carried the instrument on his head, native fashion, and never once was this instrument dropped or jarred, although the going was often over slippery trails and rough country. The second load was a large tarpaulin in which tools, nails, wire, and cloth were wrapped. The other articles were distributed between the other two boys. When a station was reached the signal was removed and the tarpaulin stretched over a frame of poles which had been prepared by the gang that poured the monument. A very good observation shelter was made by supporting this tarpaulin-covered frame on four forked poles. The instrument tripod was set on three posts driven into the ground. In order to secure an average closing error of between 2 and 3 sec. it was found necessary to turn from two to three sets on each angle. Horizontal refraction caused considerable trouble, and a satisfactory triangle closure in certain figures was not obtained until observations were made late in the afternoon.

Sections of the Du and Farmington rivers and of the Kakata Road formed part of the boundary of the Du Plantation. The boundary corners at the ends of each of these sections had been located by triangulation and the sections of the rivers and road between corners had been mapped by the plane-table stadia method. On the Du River and Kakata Road these traverses were tied in at short intervals to triangulation stations. The only triangulation control on the Farmington River consisted of the stations at the intersection of the north boundary and the river and the station at the intersection of the south boundary and the river. About 12 miles of river connecting these stations had to be run. This work was done the last part of May and the first half of June, when unseasonable rains had made the river very high. Two native canoes were used. Owing to high water it was necessary to clear the bank for practically every rod-and-table station. This survey was accomplished with con-

siderable danger to the men. The river was full of dangerous rapids and several canoes were smashed. The survey closed in position with an error of less than 1 in 600.

TOPOGRAPHIC SURVEY

Before the topographic work could be started it was necessary to establish a datum. Sea level was found by simultaneous readings of a tide gage at Port Marshall and of a river gage at Du Landing, taken at half-hour intervals over a period of 58 days.

In order to get the topographic work started as soon as possible, it was decided to do without wye levels for vertical control and depend on the elevations of the various triangulation stations determined by trigonometric leveling. Vertical angles were observed at all triangulation stations. Two sets were read on each angle—that is, two direct and two reverse, making four readings of the angle in all. The procedure followed was that described in Special Publication No. 145 of the U.S. Coast and Geodetic Survey. The height of the instrument and that of the target on the signal above the monument were carefully measured. A probable error of 0.04 m. was secured in the work to the west of the Du River and one of 0.08 m. east of it.

Topographic work was carried on by plane table; distances were found by stadia; and elevations, by the method of vertical angles. To each topographer were assigned comparatively small sections, over which he ran his traverse control and completed the topography before going to a new section of the area to be mapped. Plane-table traverse lines were run between the control points established by triangulation. When a traverse was completed, it was brought into the office and transferred to the double-mounted field sheets, on which had been plotted the projections and the triangulation control. If the traverse had a small closing error it was adjusted. If the error were large, the traverse was either re-run or the location of the error determined by re-running loop traverses off the traverse in question until the location of the error had been found. When every block corner in the area had been located by traverse and transferred to the final sheet, this sheet was sent into the field. As the location and elevation of corner pegs had been given on this sheet, it was a simple matter to set up the plane table at any point, orient it from one of the pegs, and put in the topography, streams, swamps, and culture in the vicinity. By using this system the possibility of carrying forward errors in elevations was avoided, as each set-up was located from an adjusted point, the elevation of which had been checked.

SURVEY ORGANIZATION

There was little in the way of survey organization. The first season's work was practically a one-man job, and there were only three engineers during the second year. The two assistant engineers were engaged on the topographic survey, the native reserve surveys, and plane-table traverses of the sections of the Kakata Road and the Du and Farmington rivers that formed a part of the boundary of the plantations.

Each topographic party consisted of one interpreter, an umbrella boy, and five rodmen. Ther odmen had no comprehension of the work and could not be depended upon to select the salient points. They had to be directed to each point by the engineer through an interpreter. Furthermore, the rough going underfoot and the obstruction of the line of sight by young rubber trees created additional delay. For these reasons it was found advisable to use five rodmen so that the topographer might make the most of his time.

The six men in the triangulation party had had experience during the previous year, so they were used for the most part as foremen, in charge of various phases of survey work. It was found that four men were always required for the observation party.

One car and two motorcycles were assigned permanently to the survey. The motor cycles were used by the chiefs of the topographic parties to travel from their quarters to the area in which they were working. Their parties were camped in the area under survey and were moved from place to place as the work progressed. The car, which was used by the triangulation party, proved very useful, particularly to the observation staff, as it was large enough to carry a complete party and all its equipment.

COST DATA

Cost data were kept for the second season's work. In the statement of costs given here no account is taken of the expenses incurred by the company for equipment, of the transportation expenses of the white staff to and from Liberia, or of costs incurred in completing the office work of the survey. The bulk of the cost of the work went for salaries for the white staff and native labor. The cost of materials did not amount to a great deal, and the larger part of this charge was for triangulation and boundary surveys. The principal items in the charge for materials were cement, gasoline, signal cloth, wire, lumber, nails, and bolts.

Most of the native laborers received a shilling a day. The men permanently attached to the survey parties or employed as foremen received more, the maximum wage being three shillings a day. The bulk of the labor charges was for clearing hills and lines, building towers and camps, and transporting materials such as sand and cement for the building of monuments. On the river and native reserve surveys it was necessary to do a great deal of clearing.

Triangulation costs are frequently given as the cost per station occupied or the cost per point determined. During the period under discussion, 32 new triangulation stations were located and occupied and 16 additional points determined. Many of these additional points were corners. If the total cost of this field work were apportioned among the 32 triangulation stations occupied, it would average $135 a station. If apportioned among the 48 monumented points determined, it would amount to $90 a point. Of these costs, 59 per cent went for engineers' salaries, 30 per cent for labor, and 11 per cent for materials.

The cost of the river traverses ranged from $20 a mile for the lower section of the Du River to $30 a mile for the upper section. The survey of the Farmington River, which was made in the rainy season while the water was very high, cost $50 a mile. The average cost was $30 a mile for the river survey as a whole. Of these costs, 64 per cent was for salaries of engineers, 28 per cent for labor, and 8 per cent for materials and incidentals.

Stadia methods of survey were used for 14 native reserves, ranging in size from 11 acres to 1,100 acres. The cost of the field work was $17\frac{1}{2}$ cents an acre. Of these costs, 50 per cent was for salaries of engineers, 46 per cent for labor, and 4 per cent for materials and incidentals.

The actual cost of the field work by the plane-table topography was 17 cents an acre. When a charge was applied for supervision and time used in the office in adjusting and transferring traverses, it brought the cost per acre to 22 cents. Of these costs, 77 per cent went for engineers' salaries, including supervision, 22 per cent for labor, and 1 per cent for materials and incidentals.

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of everyday experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

Determination of Ideal Curve for Open-Spandrel Arches

By S. C. HOLLISTER

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PROFESSOR OF STRUCTURAL ENGINEERING, PURDUE UNIVERSITY
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IN designing an open-spandrel arch there arises at the outset the necessity of determining the ideal curve for the particular loading to be carried. Cut-and-try

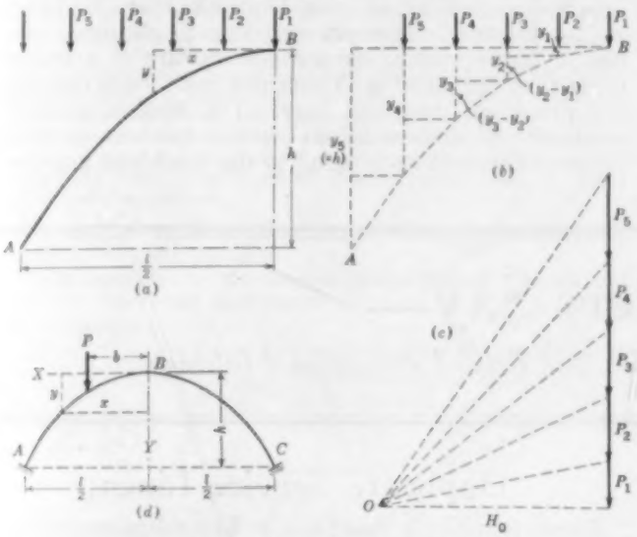


FIG. 1. AN OPEN-SPANDREL ARCH

(*a*) Loading Diagram; (*b*) Equilibrium Polygon; (*c*) Corresponding Force Diagram; and (*d*) General Dimensions

methods have long been the practice in the choice of such curves, with more or less satisfactory results. It is in the interest of securing a curve better adapted to the specific case that the following method is offered.

If loads uniformly spread along the deck were the only ones to be carried, the second-degree parabola would be the ideal curve. The spandrel columns, however, cause the loading to increase greatly toward the abutments, as do also the thickening ribs. A modified parabola reasonably meets this changing load condition. In general, the equation for the pressure line, with the origin at the crown, is in the form:

$$y = h\left(\frac{2x}{l}\right)^n$$

where h is the rise, l the span, and n an exponent chosen to suit the particular loading. The problem is chiefly to determine this exponent.

In Fig. 1(*a*) is shown the group of loads to be carried on the half span AB. For convenience, ten loads (or panel points) are chosen for the span, equally spaced. Fig. 1(*b*) shows the equilibrium polygon, as yet undetermined, and Fig. 1(*c*), the corresponding force diagram, with the final true value of H_0, or horizontal thrust, as the pole distance. From the similar triangles in Fig. 1, (*b*) and (*c*), $\frac{y_1}{0.1l} = \frac{P_1}{H_0}$. Therefore $y_1 = \frac{0.1l}{H_0} P_1$.

Similarly $\frac{(y_2 - y_1)}{0.1l} = \frac{P_1 + P_2}{H_0}$. Therefore

$$y_2 = \frac{0.1l}{H_0}(P_1 + P_2) + y_1 \frac{(y_2 - y_2)}{0.1l} = \frac{P_1 + P_2 + P_3}{H_0} \text{ and}$$

$$y_3 = \frac{0.1l}{H_0}(P_1 + P_2 + P_3) + y_2$$

From these three equations:

$$y_3 = \frac{0.1l}{H_0}(3P_1 + 2P_2 + P_3) \ldots\ldots\ldots [1]$$

Now if the equilibrium polygon as finally determined coincides with the arch axis, there is no moment or shear at any point for symmetrical loading. Hence, at A the moment in the rib should be:

$$M_A = M' + H_0 h = 0$$

in which M' is the statical moment of the loads P_1, $P_2 \ldots P_5$ about A. Thus the thrust is found to be:

$$H_0 = \frac{0.1l}{h}(5P_1 + 4P_2 + 3P_3 + 2P_4 + P_5) \ldots [2]$$

Substituting in Equation 1, there is derived:

$$y_3 = h\frac{(3P_1 + 2P_2 + P_3)}{(5P_1 + 4P_2 + 3P_3 + 2P_4 + P_5)} \ldots [3]$$

In this computation, y_3 was chosen as a point between A and B best controlling the desired form of curve to fit the pressure line. Its abscissa is $0.3\,l$. A parabolic form passing through this point and also through A and B would have the equation:

$$y_3 = h(0.6)^n, \text{ or } (0.6)^n = \frac{y_3}{h} \ldots\ldots [4]$$

Substituting the value of $\frac{y_3}{h}$ from Equation 3:

$$(0.6)^n = \frac{(3P_1 + 2P_2 + P_3)}{(5P_1 + 4P_2 + 3P_3 + 2P_4 + P_5)} \ldots [5]$$

Solving,

$$n = \frac{\log L}{\log (0.6)} \ldots\ldots\ldots\ldots [6]$$

in which L is the fractional right-hand member of Equation 5.

As an example, let each panel load equal 1. Then, remembering that $P_1 = {}^1/_2$ (panel load), Equation 6 becomes: $n = \frac{\log (0.36)}{\log (0.6)} = \frac{9.556 - 10}{9.778 - 10} = \frac{0.444}{0.222} = 2$

The equation is therefore: $y = h\left(\frac{2x}{l}\right)^2 = \frac{4hx^2}{l^2}$,

the well known second-degree parabolic curve of pressure for uniform deck load only.

As a second example, let $P_1 = 0.5$, $P_2 = 1.1$, $P_3 = 1.3$, $P_4 = 1.6$, and $P_5 = 2.0$. Then

$$L = \frac{(1.5 + 2.2 + 1.3)}{(2.5 + 4.4 + 3.9 + 3.2 + 2.0)} = \frac{5.0}{16.0} = 0.313$$

$$n = \frac{\log (0.313)}{\log (0.6)} = \frac{9.495 - 10}{9.778 - 10} = \frac{0.505}{0.222} = 2.27$$

Hence, for this loading the equation becomes:

$$y = h\left(\frac{2x}{l}\right)^{2.27}$$

It is of course possible to subdivide the arch into other than ten parts by modifying the solution to suit the condition. The thrust, shear, and moment at the crown may be readily computed for single loads, or for constructing influence lines, by letting $\frac{ds}{I} = \frac{dx}{I_0}$, where I_0 equals the moment of inertia at the crown. The equations for thrust, moment, and shear (modified from *Theory and Practice of Modern Framed Structures*, by Johnson, Bryan, and Turneaure, Part II, page 188) now become:

$$H_0 = \frac{AE - BD}{B^2 - AC}$$

$$M_0 = -\frac{(H_0 B + D)}{A}$$

in which $A = \frac{l}{I_0}$; $B = \frac{hl}{I_0(n+1)}$; $C = \frac{h^2 l}{I_0(2n+1)}$;

$$D = -\frac{P}{2I_0}\left(\frac{l}{2} - b\right)^2; \text{ and}$$

$$E = -\frac{Ph}{I_0}\left[\frac{l^2}{4(n+2)} + \frac{2^n b^{(n+2)}}{l^n(n^2+3n+2)} - \frac{bl}{2(n+1)}\right]$$

$$\text{Also, } V_0 = -\frac{1}{2}\left(1 + \frac{b}{l}\right)\left(1 - \frac{2b}{l}\right)^2 P$$

In these expressions, all dimensions are in accordance with Fig. 1(*d*). The influence lines can be readily drawn for H_0, M_0, and V_0 for the particular exponent n, as determined by Equation 6. The pressure line may now be finally placed for each load arrangement desired, from which the resulting stresses may be computed.

Deviation of the dead-load pressure line from the parabolic axis may occur when the load group is very irregular. It is doubtful if any equation could be found which would more nearly satisfy the requirements of the open-spandrel arch than the parabolic form. In concrete arches other considerations than loading—as, for instance, rib shortening due to shrinkage and plastic flow—produce moments which are of a greater order than the small ones obtained from loads only, by the procedure described here. The flexible arch rib meets all probable conditions best if it has been properly chosen as regards its relation to the dead-load polygon.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

More About D. C. Linsley

DEAR SIR: The graphic account of D. C. Linsley's experiences in the '70's as printed in your June issue interests me. This is particularly so since the author's identity, which has eluded your editors and the officers of the Northern Pacific Railroad, is known to me.

It happens that D. C. Linsley was my uncle, and I can therefore give you something of his history and professional achievements. He was born April 17, 1827, at Middlebury, Vt., and was educated at Middlebury College. In 1847 he began his engineering career with the Rutland and Burlington Railroad, being engaged for three years in its survey. Later, from 1851 to 1855, he supervised construction on the Illinois Central Railroad, from which work he returned to Vermont and engaged in writing a book on the Morgan horse, on which subject he was considered an authority. He also published the *Vermont Stock Journal*, which had a wide circulation.

In 1859 he contracted to build a section of the Central Vermont Railroad north of Burlington, involving the construction of the first tunnel through sand in this country. His service with the Northern Pacific Railroad in the West, of which his diary gives one interesting phase, extended over three years, and at its completion he returned to the East to construct the Canada-Atlantic Road from Ottawa to Coteau, Province of Quebec.

Still later he went to New York City where, according to an obituary note in a Vermont paper, he worked on a "Rapid Transit Road" from Boston to New York. At the time of his death, October 7, 1889, he was engaged on the plans for a gigantic elevated railroad system in the metropolis.

CHARLES W. LINSLEY, M. Am. Soc. C.E.

Oswego, N.Y.
June 7, 1932

Duplicate Service Lines

TO THE EDITOR: I should like to take this opportunity to commend Mr. Consoer's suggestion, made in his article in the March issue, for revising standards for the location of underground utilities for duplicate services, as originally suggested by the committee for the Chicago Regional Planning Association. He has suggested that the water and gas mains be moved toward the property line, so as to bring them between the curb line and the property line.

This subject was given consideration during the last few months of 1931 by the Committee on Utilities of the President's Conference on Home Building and Home Ownership. The report of this committee is given in the recently published volume, *Planning*

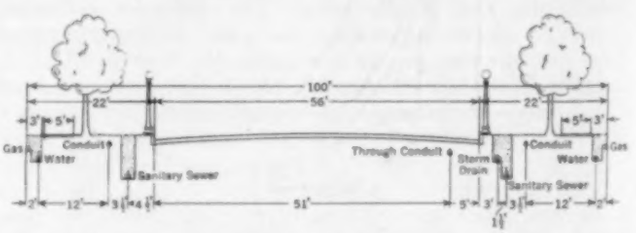


FIG. 1. LOCATION OF UNDERGROUND UTILITIES FOR DUPLICATE SERVICES

for Residential Districts. In regard to the possibility of locating the subterranean utility lines outside of the paved portion of the street, it is stated on page 131 of this report that:

In streets having expensive pavements, it is usually advisable to permit only the storm-water sewer and through-run conduits of

electric and telephone companies under the pavement. The rest of the pipes should be located under either the planting strips or sidewalk. If they are placed under the sidewalk, the sidewalk should be a material that is easily replaceable and not monolithic concrete. After an expensive pavement is laid, there seldom should be reason for having it broken at all for installation of service lines or repairs to service lines.

From this it will be noted that the report of the committee goes even further than Mr. Consoer's suggestions and recommends not only that gas and water lines be moved from under a hard-surface paving, but also that sanitary sewers and local electric and telephone service lines be placed between the curb and property lines. Where conditions permit these recommendations to be carried out, the possibility of tearing up hard paving for utility repairs or connections will be remote indeed. With proper planning and cooperation between the utilities and the municipalities, it can be made reasonably certain that no additions to the utilities will be necessary during the life of the pavement.

In the interests of economy and general orderliness, the committee made favorable recommendations for the joint use of trenches by various utilities. The experience of the members of the committee in actually carrying on construction work under these cooperative conditions was such that the following recommendation was incorporated in the report (page 134):

While there have been successful installations of all utilities in the same trench, there are many reasons for believing that the most satisfactory procedure is a modification of this plan. The committee recommends that gas and water occupy the same trench, that a second trench be used for electricity and telephone, and that sewers be placed in a third trench. There are thus three trenches instead of five, with the resultant economy, but without the danger of contamination of the water supply by sewage from a leaking sewer, or the possibility of escaping gas entering the house through the electric and telephone conduits, when the latter are placed underground.

A typical cross-section of the location of underground utilities for duplicate services is shown in Fig. 1.

Those interested in the subject of underground utilities will find that this report supplements in many ways the paper by Mr. Consoer.

NATHAN B. JACOBS, M. Am. Soc. C.E.
Vice-President and Treasurer
Morris Knowles, Inc.

Pittsburgh, Pa.
May 16, 1932

First-Order Control Important

TO THE EDITOR: I read with interest Mr. Syme's article on "Geodetic Control for North Carolina Highways" in the March issue. All triangulation should be of the first order as the difference in cost between first- and second-order triangulation is small and first-order triangulation may sometimes be needed where the second only is available.

The establishment of azimuth at each triangulation station is an excellent idea, but general use of it for any but large surveys must await its extension by monumentation throughout the district to which it applies. Some state authority or engineering society should designate the division lines for the limits of any particular azimuth. Azimuth should be named according to the locality, and in the preparation of title descriptions care should be taken to mention the azimuth to which the courses refer.

The general adoption of such control depends upon the work of the highway commission in building up a supplementary system of monumentation covering present state highways. It is presumed that monuments will be set at every cross-road so that county and other engineers will have these reliable points for beginning and tying in secondary road surveys. If surveys are tied in with the proper degree of care, there will soon be a complete network over the entire state.

A degree of accuracy of 1 part in 5,000 is mentioned by Mr. Syme. In cities and towns the degree of accuracy should be 1 part in 10,000 and can be made so at trifling additional expense. It would be very helpful to city engineers if one or more triangulation points could be placed near towns and cities, thus stimulating the city engineer to work out a system of control for his own city. The need for control surveys is clearly demonstrated by Mr. Syme's description of the methods which have obtained up to this time—that is, starting from an assumed meridian and an assumed bench mark for each survey. It would be interesting and informative to estimate the waste in time and money which this method involves.

Fudging, overlapping, failure of property lines to join, and even expensive reconstruction are a logical sequence of the lack of basic control. The recovery of original work is often time-consuming and may involve great expense. The state should lead the way in establishing and monumenting so that its property lines will be fixed beyond question. It should have records available so that any section may be easily and quickly recovered. The setting-up of a public agency to collect, map, and even monument surveys that have been checked and found satisfactory is of value in securing the widest benefits. Engineers will find this of great advantage to their clients.

North Carolina has shown herself so progressive that it is fitting she should lead the way in utilizing control surveys and thus lay a proper foundation for all future surveying operations, public and private, within her borders. The importance and value of this in the years to come cannot be overestimated any more than can the extravagance and uncertainty of the prior disconnected methods. After engineers have used the control survey they will wonder how they managed to work without it. If North Carolina shows the way to a new era in surveying and mapping, it is hoped and believed that other states will rapidly follow.

HENRY J. SHERMAN, M. Am. Soc. C.E.
Consulting Engineer, New Jersey Board of Commerce and Navigation

Camden, N.J.
May 1, 1932

Geodetic Survey of Residential Area

DEAR SIR: As an illustration of the value of a triangulation network, mentioned by Mr. Syme in the March issue, my experience in surveying residential and resort property on Long Island, N.Y., may be of interest.

Approximately 11,000 acres, extending in a general northeasterly direction 9.2 miles along the Atlantic coast, were involved. Presumably because of the configuration of the coast line, there were ten triangulation stations of the U.S. Coast and Geodetic Survey in this area. Certain sections of the property were covered by two smaller triangulation nets accurately executed in 1897. These stations were recovered, tied in, and used with the Survey net as the nucleus of a horizontal and vertical control system, to which additional control stations were tied by triangulation.

One Survey station, chosen near the center of the property to minimize the error in bearings resulting from convergence, was used as the origin of a plane coordinate system covering the entire property. The geographic positions of all other geodetic stations and adjusted values of triangulation and traverse stations were transformed to coordinate values in this plane, all bearings being referred to the true meridian through this origin. The stations of this control skeleton were interconnected by precise traverses, adjusted and closed on triangulation stations. In 1925 these had been monumented and used as control for a complete topographic survey by W. N. Brown, M. Am. Soc. C.E., who suggested this plan.

When this control system was established, with about 900 monumented points, its use by state highway, park commission, and U.S. Army engineers operating in the locality naturally followed.

In writing metes-and-bounds descriptions for the conveyance of property outside the area covered by plats filed in county records, the location of points of beginning was referred to the nearest or most convenient control monument, the position of which was designated by plane coordinates referred to the central Survey station. The Survey stations, in addition to fulfilling all the legal requirements of superior control, had also the virtue of being immediately recoverable if destroyed. Some 400 conveyances of property involving several millions of dollars were made and recorded before the legality of the use of this control was challenged. The challenging parties eventually became defendants in a case tried before the Supreme Court of the State of New York. The substance of the court ruling was that the use of Survey control for

reference purposes in delimiting private land boundaries could not be sustained as an objection to the clarity of the description or the validity of the deed.

To reduce the possibility of future litigation and attendant expense, a plan was evolved by E. P. Clark, lawyer and engineer for the Title Guarantee and Trust Company, Brooklyn, N.Y. We have since carried out this plan, by which property surveys based on geodetic control and plane coordinates are made to conform to certain legal precedents evolved from the use of older but less accurately controlled methods, by filing in the county records a map of the control skeleton and a declaration explaining in general how the control is used.

The exclusive use of this control from 1925 to date has convinced us that the initial expense of establishing it is returned very promptly and a resultant net saving soon appears, in the reduction of the average cost of surveys and the ease with which a higher standard of accuracy is maintained.

T. E. RINGWOOD, Assoc. M. Am. Soc. C.E.
Chief Engineer, Montauk Beach Development Corporation

Montauk, Long Island
May 27, 1932

Inconsistent Roughness Coefficients

SIR: The article by R. J. Paulette entitled "Measuring the Discharge of the Smoky Hill River," in the April issue, interested me greatly. As far as may be judged from the pictures, and from tabulated values of slope and hydraulic radius, the Smoky Hill at Salina is not different from the same stream at a point between Abilene and Enterprise, 25 or 30 miles downstream, except with regard to size. The coefficients obtained by Mr. Paulette, however, are very different from those obtained from my study of the river above the Hoffman Dam at Enterprise, during a flood in the summer of 1915.

TABLE I. SMOKY HILL RIVER NEAR ENTERPRISE, KANS., DURING THE FLOOD OF 1915

Calculations of the Coefficient C in $V = C\sqrt{RS}$ and the Kutter Coefficient of Roughness, n, for Q = 14,500 Sec-Ft.

Section	Distance in Ft.	Av. Area in Sq. Ft.	Fall in Ft.	Values					
				S	p	R	V	C	n
2–7	3,730	3,005	1.36	0.000365	293	10.25	4.83	79.1	0.028
7–16	5,270	3,443	1.64	0.000311	342	10.04	4.21	75.6	0.030
16–24	5,300	3,532	1.55	0.000293	318	11.10	4.10	72.1	0.032
24–31	4,760	3,545	1.28	0.000270	329	10.77	4.09	75.7	0.030
31–37	3,720	3,979	0.41	0.000110	398	10.00	3.64	110.0	0.020
37–52	6,080	3,946	1.86	0.000306	323	12.21	3.68	80.0	0.040

The profile of the crest of this flood was marked by the county engineer at several points over the stretch of river from below the dam to the Kyle Bridge. Also float measurements of the velocity of the

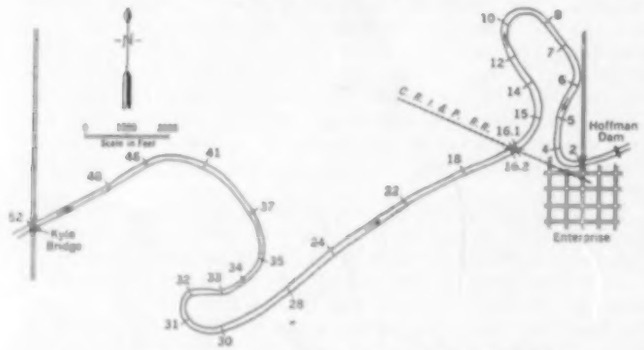


FIG. 1. SMOKY HILL RIVER NEAR ENTERPRISE, KANS.

stream were made in two places—one between sections 5 and 6, and one between Sections 22 and 24 (see Fig. 1). I later ran a tape and transit traverse over this stretch of the river, established bench marks, and made cross sections of the bed of the stream at 27 sections.

For the rate of discharge, Q, one value was obtained, after careful Hoffman Dam. This was calculated as 14,500 sec-ft. Float measurements made use of a 2 by 4-in. timber, 12 ft. long, weighted so as to float in an upright position. Applying a coefficient of 0.85 to the velocity of the float in the central part of the stream to obtain the mean velocity, a value of

Q = 16,700 sec-ft. was obtained between Sections 22 and 24, and
Q = 14,700 sec-ft. between Sections 5 and 6.

The values of C and n, shown in Table I, are based on the value of Q obtained by submerged weir calculations. Subsequent current-meter measurements indicate that a bank-full stage is in excess of 12,000 sec-ft., whereas the 1915 flood was more than bank full.

It would be necessary to have a value for Q as small as 8,000 sec-ft. to bring the results into line with the Salina coefficients. If such a value is the true value, then that used in the calculations was about 80 per cent too great. I doubt if the value used, 14,500 sec-ft., was as much as 10 per cent too great.

If it is agreed that the measurements of slope and area are reliable and that the estimate of Q is not far from correct, then the conclusion must be that it is very difficult to judge, even after careful examination of all evidence, what may be the proper value of the Kutter coefficient of roughness for any natural water course. It is my belief that the only legitimate use for such formulas as the Chezy formula, with values of C by Kutter, Manning, Bazin, or any other, is for the design of artificial channels with uniform cross section and regular alignment and slope.

J. O. JONES, Assoc. M. Am. Soc. C.E.
Professor of Hydraulics, University of Kansas

Lawrence, Kans.
June 6, 1932

Bulb Piles Successfully Used

TO THE EDITOR: Under the title, "Foundation Methods Involving Piling," in the May issue of CIVIL ENGINEERING, Mr. Miller has given some of his experiences over a period of years, and has further opened up the question of how the carrying capacity of piles may be analyzed.

The pile industry of today must adapt itself to the scientific research which has been made in recent years in various parts of the world. The advisability of obtaining test borings cannot be too strongly emphasized. These can be used to determine not only what type of pile should be chosen but also whether piles are the correct or most economical form of foundation to adopt.

Although it has been generally understood that piles act as columns to convey the load to a hard stratum at their points, their use is primarily to compress the top soil and then to convey the total pressure to some compact load-bearing stratum below.

The theories of load distribution by the bulb of pressure are easily applied to the type of pile with an enlarged base. For small clusters made up of three or four piles this is doubtless the most scientific form of pile. I selected it recently because of its adaptability to transmit load, as the site was reclaimed land filled in with ashes and rubbish for a depth of about 15 ft. The piles were in small clusters, and a fair-sized bulb was obtained.

In many cases where piles are chosen, proper study of the problem would result in the selection of caissons or caisson piles, especially where there is a moderately deep clay fill and the soil offers considerable resistance to the passage of water. Settlement of piles is caused by the inadequacy of the underlying strata to support the superimposed loads and not by slipping or loss of skin friction. The formation of a bulb at the pile point can do no more than give a greater factor of safety against settlement.

Discussions on "The Science of Foundations—Its Present and Future," by Charles Terzaghi, M. Am. Soc. C.E., in Vol. 93 (1929) of TRANSACTIONS, have brought to light the fact that the so-called "Engineering News formula" is misleading and totally wrong for certain soils and conditions. However, it is generally used by pile companies and others, irrespective of the type of pile and other factors.

H. H. MARSH, M. Am. Soc. C.E.
Chief Engineer, Municipal Architect's Office

Washington, D.C.

More Cooperation Needed

TO THE EDITOR: If Mr. Goodrich's letter, in the May issue, is brought to the general attention of engineers, it may destroy the fallacious code that it is unprofessional and unethical for engineers to suggest projects involving expenditure of money, to those who have money. Such an attitude of false modesty must kill initiative and, incidentally, prevent the development of beneficial projects. For years I have found it interesting to suggest projects. There are really 640 "acres of diamonds" per square mile in the area of every large city, and the possibilities of these acres extend from groundwater level up to the height limit of the tallest building. There is, somewhere, somehow, a use for that long-closed factory building—after it is partitioned and divided it may be rented to a number of small and varied industries. An assemblage of several separately owned parcels of land into one ownership and use sometimes provides the space and other requirements for a special and needed purpose. Nothing should be despised—even the layout of a cemetery means some months of work for an engineering office.

The second suggestion by Mr. Goodrich of an "affiliation, temporary perhaps" is good. As a rule, the average engineer is known and has his clientele only in the limited district in which his practice is located. His self-starter ideas, however, may be just the hint required by a brother engineer to make some project operative in another district. Engineers as a class usually are not friendly enough with each other. The investor, too, will be glad to listen to any suggestion which may come from a sensible engineer, especially at a time when he may have found nothing to which he can fasten his own ideas.

As a closing hint, I believe that, for some years at least, the thoughts of most big investors will more than before be centered upon actual necessities—upon projects and methods offering economies to the masses. Let it be remembered that very little of importance can be achieved without the knowledge, experience, and service of the engineer—using the term in a broad sense of the word—and that when the engineer works the world also works and moves.

HAROLD G. WYNNE, M. Am. Soc. C.E.
Consulting Engineer

New Haven, Conn.
May 9, 1932

Parabolic Formula in Error

DEAR SIR: The article, "Design of Flange Plates for Deck-Plate Girders," by C. M. Goodrich, in the April issue, is of especial interest to me because of a similar study which I made several years ago.

Although the actual moment curve for locomotive wheel loads lies outside the true parabola for all span lengths, it was found that for spans up to 70 ft. the difference was so slight that the conventional parabolic formula, with 3 ft. added, proved satisfactory for the purpose of design. When the span length exceeds 70 ft., the error of the conventional method becomes apparent, and the error increases as the span increases.

To overcome this error, the late F. C. Kunz, Assoc. M. Am. Soc. C.E., in his treatise, *Design of Steel Bridges*, published in 1915, proposed a formula for the theoretical length of cover plates, which, using Mr. Goodrich's notation, is as follows:

$$l = L\left(0.1 + 0.9\sqrt{\frac{a}{A}}\right)$$

I found that the theoretical length of cover plates can be closely determined by the formula:

$$l = L\sqrt{\frac{a + 0.05A}{1.05A}}$$

A simple but effective rule to determine the design length of a cover plate is to find the theoretical length by the conventional parabolic formula, and to this add one-twentieth of the span length.

H. D. HUSSEY, Assoc. M. Am. Soc. C.E.
American Bridge Company

New York, N.Y.
May 19, 1932

Concrete Facing Unnecessary

DEAR SIR: The article by Mr. Griffin on "Protection of Concrete by Glazed Tile," in the June issue, is most interesting. However, I cannot see the necessity for facing concrete structures with glazed tile or any other facing material, if the concrete is properly designed for the exposure it is to withstand and if a few elementary principles for the design and control of concrete mixtures are observed. The question of aggregates should also receive a great deal of consideration, particularly in Canada where the temperature shows the large differential noted in Mr. Griffin's article.

We know that one of the most destructive agents of concrete is alternate freezing and thawing while the concrete is saturated with water, and that in parts of Canada, as well as the western section of the United States, the presence of alkali (sulfate) groundwater presents a serious problem. In consequence, unless a concrete structure, such as that mentioned by Mr. Griffin, is of durable concrete, cycles of freezing and thawing cause existing cracks to widen and deepen until spawling and disintegration take place.

However, I am of the opinion that durable concrete, which will give satisfactory service in any climate, can be made by keeping in mind the following facts: (1) For successful outdoor structures durability must be made a basic consideration of equal, or even greater, importance than strength. (2) Durability, water-tightness, and strength are inter-related and are equally amenable to control in concrete construction. (3) The factors which assure durability of concrete are durable aggregates, cement-water paste which, when hardened, is durable, and proper incorporation of the aggregates in the paste.

The factors affecting the quality of the hardened paste are the characteristics of the cement, the water-cement ratio, and the conditions of curing. Proper incorporation of the aggregates in the paste involves the quantity of paste used, the grading of the aggregates, a suitable consistency, and care in handling and placing.

S. S. NEFF, Assoc. M. Am. Soc. C.E.

Buffalo, N.Y.
June 7, 1932

Street Names May Be Eliminated

TO THE EDITOR: The article by Mr. Schwada on "Street Names and House Numbers," in the March issue, is of particular interest to me. In connection with it, I should like to outline a system of my own for numbering streets and houses which would permit a traveler to find any address without a map or other assistance. This system may be applied in any city without serious cost. It provides for two axes or coordinates intersecting near the center of the city. If two coordinate values are given for any point, that point will be accurately located. For example, the term, "372 East, 296 South," locates an area 12 ft. square, if the unit used is 12 ft. The average distance covered by one number on one side of a street is 12 ft. or less.

Where street names have been established for a long time or there is a great deal of sentiment connected with a historic name, the name of the street may be given in addition to the accurate location above indicated. For example, the designation, 227 E. 150 S. Washington Avenue, will locate the point accurately and, at the same time, satisfy those who have sentimental reasons for retaining the name of the street. Signs placed at street intersections will give the distances of these intersections from the two rectangular axes. The traveler going south will then have prominently before him, at each intersection, his distance south of the east and west axis. In smaller figures on the same street sign will be given his distance east or west of the north and south axis. Similarly, a person traveling in an eastern direction will find a sign at each intersection indicating clearly how far he is east or west of the north and south axis and, in smaller figures, how far he is north or south of the east and west axis.

With such a system of street signs, a traveler can find an address —such as 1321 E. 450 S.—without a map or other aid. Of course, the street name may be added to this definite location if it is wanted, although it is unnecessary.

RICHARD R. LYMAN, M. Am. Soc. C.E.
Consulting Engineer
Metropolitan Water District of Southern California

Salt Lake City, Utah
May 18, 1932

SOCIETY AFFAIRS

Official and Semi-Official

Engineers' and Architects' Relief Program in Boston

Under the Direction of the Engineers' Executive Committee

By JOHN F. PIERCE

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
EXECUTIVE DIRECTOR, EMERGENCY PLANNING AND RESEARCH BUREAU, INC.

IN the May issue, pages 329 and 330, there was printed a brief statement of the work being done by the Emergency Planning and Research Bureau, Inc., of Boston, which was organized early in 1931 to carry on the relief of the unemployed in the engineering and architectural professions. In the following statement, the organization and results accomplished are outlined for the benefit of committees and members of the Society who have been performing a similar service elsewhere.

IN THE late fall of 1931, Harry E. Sawtell, M. Am. Soc. C.E., then president of the Boston Society of Civil Engineers, and William Stanley Parker, president of the Boston Society of Architects, initiated a survey of the unemployment situation in their respective groups. The financial condition of some of the men was found to be critical and it was apparent that there would be many men of both professions out of work by the first of the following year. It was likewise evident that some form of relief was necessary, and Mr. Parker suggested that the two professions cooperate in solving the problem.

His plan was to collect funds from those employed in the professions and to give relief employment to the needy unemployed members by using their services on work of public character, such as assisting city planning boards and civic organizations in research work. The single group of architects started to function promptly and was able to put the first man to work the day before Christmas, 1931.

The great extent of the problem being realized, the suggestion of Mr. Parker was placed before the Engineering Societies of Boston, which is composed of 13 member societies. The plan was immediately endorsed and a committee appointed with instructions to relieve the distress among unemployed engineers and to cooperate with the architects. An Engineers' Executive Committee was appointed and five working subcommittees were established, known as Finance, Registration, Administration, Development, and Publicity. Subcommittees were organized in different sections of the state to handle unemployment relief in their communities. These are self-contained committees in that they raise their own funds and take care of their own unemployed. As it was expected that the funds of the main committee would be collected within the Boston Metropolitan District, it did not appear feasible to use these funds for relief in other centers. Later it became evident that contributions were received from outside this district, and consequently relief was extended to society members living outside.

An advisory group composed of five men outside the profession was organized with the request that they study the situation in the hope of advising as to the best methods to be used, and types of work to be undertaken, with particular reference to the long-range usefulness and support of the bureau.

The Engineers' Executive Committee assumed the responsibility of representing the American Engineering Council, under the name of the Massachusetts Committee on Engineers and Employment.

On January 9, 1932, the first man was set to work. Up to June 16, a total of 198 engineers have been given employment. During the same period, 121 architects have been placed. To date, a total of 865 engineers and 212 architects have registered as being in search of employment.

EMERGENCY PLANNING AND RESEARCH BUREAU, INC., ORGANIZED

The committees of both professions organized the Emergency Planning and Research Bureau, Inc., a non-profit-making corporation through which the two professions now function. This organization is divided into two divisions, known as the Engineers' Division and the Architects' Division. Each division collects and administers its own funds, selects the type of work which the men are to do, and keeps its own accounts, all these activities being coordinated through the Board of Directors of the bureau.

Funds were raised by the Finance Committee through pledges secured from members of the profession who were at work. They generally contributed a day's pay per month for a period of 20 weeks beginning January 24, 1932. The Finance Committee organized a system of team captains covering large organizations, and by letter appeal solicited pledges from the society membership and other engineers of the metropolitan territory. Funds were also received from individuals and organizations interested in the two professions. In this manner $79,004.62 was raised, representing 2,429 pledges. Up to June 16, 1932, $62,024.02 had been received and the period covered by the pledges was not yet up. The Administrative Committee receives and disburses all funds through the treasurer and keeps the financial books of the bureau.

Contact was established with the United Boston Unemployment Relief Committee, which was just starting its drive for funds, so that the work of our committee would parallel rather than compete with it. Contributions received by our committee were credited in the amount received by the United Boston Campaign, although the United Boston Committee had nothing to do with the handling of funds collected by the bureau. Every contributor to the Engineers' and Architects' Welfare Fund received the same card and button as were given to contributors to the Boston Relief Campaign, thereby avoiding the annoyance of anyone's being requested to donate to both organizations.

REGISTRATION OF APPLICANTS

In addition to the standard information on education and experience, every applicant seeking work and registering with the bureau is asked for his exact financial condition at the time of application. If his case is critical from the financial viewpoint and appears to warrant relief, the bureau requests the social welfare organization in the town in which the applicant resides to make an independent report on the case. This report, with the copy of the registration of the applicant, is reviewed by the Registration Committee, a member of which personally interviews each man. When the committee is satisfied of the acuteness of the individual case, the applicant is referred to the chairman of the Administrative Committee, where his name is placed on the pay roll. The applicant is then sent to the drafting room of the bureau, where he is assigned to work.

Every registrant is classified as to whether or not he belongs to any of the member societies of the Engineering Societies of Boston, and grouped according to his training and experience—such as civil, mechanical, electrical, or heating and ventilating. In addition, an index card is made of his qualifications, such as surveyor, concrete designer, boiler inspector, or electrical draftsman.

In determining the work which these men shall do, the Development Committee has followed three general principles:

1. That the work shall not conflict with any employed enigneer and that it shall not take work away from any engineer.
2. That the work must be of such a nature as to come within the classification of engineering.
3. That not only will the man himself be benefited, but that there shall be a possibility that the project will open more work for the engineering profession or that it will be demonstrated that an engineer is the logical man for that type of work.

TYPES OF WORK DONE

The projects are of a varied nature, and include:

Work for the City of Boston with the Architects Division on mapping of city-owned property and blocking of the 1930 census, housing studies, depreciation studies of downtown business sections, and correction of maps for street changes for the Planning Board.

Work in connection with state departments for which there have been no funds available, such as fire protection studies at institutions, surveys in connection with public reservations, smoke investigations, traffic counts, plotting statistical data, surveys of state institutions, gathering of existing data on refrigerating and heating plants at state institutions.

Compilation of existing facts relating to New England that can be used for a regional study of this area, such as trends of population, transportation, local government finances, present status of zoning and use of land in each county.

Library research work for committees of various engineering societies.

EMPLOYMENT BUREAU ESTABLISHED

Within the bureau there has been set up an employment service operated under the laws of Massachusetts and the City of Boston. During the present emergency, there is no charge to the employer or to the employee for any contacts that may be made. Two employees of the bureau devote their full time to this work. These men make contacts with prospective employers, such as department stores, real estate offices, banks, and similar organizations which ordinarily do not employ engineers, to "sell" the idea of "Use Engineers," and ask their cooperation in looking to the bureau when they are in need of additional employees. During the period in which this service has been operated, 43 men have been placed in positions where their total income to date is estimated as $10,640. In addition, 74 registered men have gone into work of varied nature from which there is no income record. The yearly income of the men registered and now employed elsewhere is estimated to be $210,000.

The Engineering Division is under the active direction of an Executive Director, who devotes his entire time to the work. He is responsible for the employment bureau, the assigning of work to the men, keeping the cost of each individual project, preparing the pay rolls, registering the applicants, making the investigations, and preparing a weekly report of activities for the committees.

The office space has been donated by the Edison Electric Illuminating Company of Boston, and the equipment by various engineering organizations. The stationers and makers of blueprints are cooperating in this work by making donations and furnishing material at a substantial discount. The men work seven hours a day, five days a week, at the rate of $3 a day.

SHORTER HOURS FOR SUMMER SCHEDULE

During the summer months the bureau is carrying on, although some curtailment has been necessary. In view of the prospect for continued poor business in this section of the country, the Executive Committee is contemplating the necessity of extending the work of the bureau into next winter. Because living conditions are not so severe in the summer, the number of men on the pay roll has been reduced 25 per cent of its maximum and in addition men are working but three weeks per month. This "vacation" period of one week is rotated so that some men are always working. It is expected that this curtailment will enable the bureau to carry on the present program until fall, when it will be necessary to make another campaign for financial assistance. The number of applications received weekly during the past month indicates that more men will be in need of assistance in the near future. There appears to be no let-up in the number of new men seeking employment.

The men now receiving assistance have been thoroughly investigated; they are all married men with one or more dependents. The average number of dependents per employee is over three. For the 130 men on the pay roll, the weekly disbursements average $1,600. The total pay roll expenditure to June 16 has amounted to $35,977.50, which is 96 per cent of the total expenditures of the bureau.

Of the 865 men who have registered with the bureau, 621, or 71.8 per cent, are non-members of any engineering society, as can be seen from the table below. The largest number of society members is in the civil engineering group; and the next largest, in the mechanical engineering group.

CLASSIFICATION OF REGISTRANTS

Registrants in Metropolitan Boston	691
Registrants outside above area in Massachusetts	149
Registrants in other states	25
Total number of registrants	865
Percentage engineering graduates	29
Percentage non-engineering graduates	71
	100

As is to be expected, the majority of the applicants are from Metropolitan Boston. There are 25 registrants from outside Massachusetts. The largest number of applicants are between the ages of 26 and 30, numbering 162, followed by 116 registrants between the ages of 21 and 25. An additional age analysis may be found in the table which follows. Of the registrants, 29 per cent are graduates of engineering schools.

APPLICATIONS IN AGE GROUPS

Ages 18–20	6
Ages 21–25	116
Ages 26–30	162
Ages 31–35	111
Ages 36–40	108
Ages 41–45	70
Ages 46–50	32
Ages 51–60	27
Ages 61–67	6

Favorable publicity has been given the bureau by the newspapers of Boston, by invitations to supply speakers for organizations, and by exhibits at conventions and in clubs. This work has been handled by the chairman of the Publicity Committee through a publicity director of one of the public utilities, who has devoted his time gratis to this work.

RESULTS

The development of the present welfare plan by the Emergency Planning and Research Bureau, Inc., has resulted in:

1. A better understanding among the individual engineering societies comprising the Engineering Societies of Boston.
2. A better understanding of the engineering profession by the general public.
3. The practical example of a well-planned and smoothly operating

SOCIETY MEMBERS AND NON-MEMBERS REGISTERED AND PLACED

Society	Number of Men Registered	Percentage of Total Registered	Number of Men Placed	Percentage of Total Placed	Percentage of Registered Placed
Boston Society of Civil Engineers	80	9.2	22	8.9	27.5
New England Water Works Association	3	0.3	1	0.4	33.3
Plant Engineers Club	1	0.2	1	0.4	100.0
Boston Section, American Institute of Electrical Engineers	57	6.6	13	5.3	22.8
Boston Section, American Society of Mechanical Engineers	62	7.1	5	2.0	8.1
Northeastern Section, American Society of Civil Engineers	17	2.0	6	2.4	35.2
Boston Section, American Institute of Mining and Metallurgical Engineers	3	0.3	1	0.4	33.3
Massachusetts Chapter, American Society of Heating and Ventilating Engineers	3	0.3	2	0.8	66.7
Boston Chapter, American Association of Engineers	3	0.3	2	0.8	66.7
Boston Section, American Welding Society	1	0.2	..	...	....
Northeastern Section, Illuminating Engineering Society	2	0.2	2	0.8	100.0
Massachusetts State Engineers' Association	11	1.3	4	1.6	36.4
Boston Section, American Society of Refrigerating Engineers	1	0.2	1	0.4	100.0
Total Members	244	28.2	60	24.2	24.6
Total Non-members	621	71.8	187	75.8	30.1
Grand Total	865	100.0	247	100.0	28.6

welfare organization, which has been cited as a model for other groups attempting to solve the relief problem within their ranks.

4. Improved morale of the unemployed engineer, who has been made to feel that he is producing work of value along the lines in which he has been trained, instead of feeling that he is a recipient of charity, giving nothing in return.

5. A closer relationship and a better understanding between the architects and engineers.

Planning for the Fall Meeting in Atlantic City, October 5–8, 1932

TO THOSE who have experienced the charm of a few days in Atlantic City in early October, further invitation to the Society's Fall Meeting would be superfluous. For others, a brief description may be in order.

By that time the throngs of summer visitors are gone and this famous shore resort is left to those who enjoy the sea, free from the crowds, the turmoil, and the heat of midsummer. The air is still balmy and the bathing attractive; the renowned boardwalk, with its well known shops, is fully patronized. And the neighboring golf links are not only more attractive but less crowded. All in all, the city and its surroundings are at their best. Whether the visitor is looking for an active technical meeting with plenty of sociability, formal and informal, or whether he wishes to enjoy fully the invigorating sea air with his family, he will find his wants supplied.

Conventions and Society Meetings are no novelty to the Chalfonte-Haddon Hall Hotel. It has been the meeting place of the American Society for Testing Materials for several years. One of the largest and best known hotels in the city, it has been chosen by the committee of arrangements for its experience as well as its appointments. Meeting halls ideally fitted for our needs are available; and rooms to meet every requirement and purse are to be had in large numbers. As far as physical surroundings are concerned the conditions will be ideal.

The Philadelphia Section, which will act as host, has been active for many months in preparing for this event. Committees covering the various phases of the meeting are already perfecting their plans. The preliminary program suggests a most stimulating mental and social diet. Nothing seems to be forgotten. The many members who enjoyed the previous Society Meeting under the auspices of the Philadelphia Section—the well remembered Convention at the time of the Sesqui-Centennial, in 1926, which was also held early in October—will have no misgivings. They will know that the 1932 Fall Meeting is bound to be an outstanding success.

Appointments of Society Representatives

C. C. VERMEULE, M. Am. Soc. C.E., was appointed to represent the Society at the inauguration of Robert Clarkson Clothier as president of Rutgers University, New Brunswick, N.J., on June 11, 1932.

KARL E. HILGARD, M. Am. Soc. C.E., has been appointed to represent the Society at the International Congress of Mathematicians, to be held in Zurich, Switzerland, September 4 to 12, 1932.

C. W. HUDSON, M. Am. Soc. C.E., was appointed Society representative at the inauguration of William A. Boylan as president of Brooklyn College, Brooklyn, N.Y., on June 21, 1932.

News of Local Sections

BUFFALO SECTION

At the annual meeting of the Buffalo Section, held on May 10, officers for the year 1932–1933 were elected as follows: Nathan H. Sturdy, President; George F. Unger, Vice-President; and Roswell S. Buck, Secretary-Treasurer.

CENTRAL OHIO SECTION

Various business matters of a routine nature occupied most of the session of the meeting of the Central Ohio Section, held in Columbus on May 19. Following this, Prof. F. H. Eno spoke on "Some Interesting Experiences with Glacial Bogs." This talk was particularly interesting to highway members. Attendance at the meeting numbered 32.

CLEVELAND SECTION

There were 92 members and guests in attendance at a dinner meeting of the Section, held at the Chamber of Commerce Club on May 9. An orchestra from the office personnel of W. E. Pease furnished part of the musical entertainment provided for the occasion. The speaker of the evening was Thurman Miller, president of the Daily News-Journal, Wilmington, Ohio, who spoke on "Finding the Corner in a Circle."

DAYTON SECTION

The May meeting of the Dayton Section, held on May 9, consisted of a luncheon, followed by an inspection trip through the new Bell Telephone Building. There were 20 in attendance. On May 23, a special meeting was called to hear the report of the recently appointed Traffic Engineering Committee. There was considerable discussion of the "Program for Public Works Construction," recently approved by the Executive Committee of the Society. Attendance at this meeting numbered 14.

LOS ANGELES SECTION

The unusually large attendance at the regular monthly meeting of the Section, held at the California Institute of Technology on May 11, was justified by the exceptionally interesting program. After the usual business procedure, Prof. R. Sorensen gave an illustrated lecture on the work being done in the high-voltage laboratory at the California Institute of Technology. The other speaker was Dr. Clark Milliken, who discussed some fundamental problems of aeronautical design and described the basic problems of aerodynamics.

MARYLAND SECTION

To stimulate the interest of its younger members in Society affairs, the Maryland Section offered a prize for the best paper presented by a Junior during the year 1931. This prize has been awarded to J. H. Engel for his paper, "Structural Features of Airplane Wing Design."

The Student Chapter of Johns Hopkins University had charge of a meeting of the Section held in Baltimore on May 19. An illustrated address was given by R. B. Bortner, a senior member of the Chapter, on "The Significance of the South Manchuria Railway."

PHILADELPHIA SECTION

On May 19, members of the Philadelphia Section enjoyed an inspection trip to various engineering projects either under process of construction or else recently completed in the city. Among the points of interest visited were the Market Street subway extension, the tube under the Schuylkill River, and the Pennsylvania Railroad's new passenger terminal improvements. In the evening a dinner meeting was greatly enjoyed. Among those who spoke were: Charles H. Hitchcock, Designing Engineer, Reading Company; Charles H. Stevens, Chief Engineer, Department of City Transit; and Carlton B. Jansen, Superintendent of Construction, Dravo Contracting Company.

There were 186 who made the inspection trip, 110 in attendance at the dinner, and 165 at the meeting that followed.

PROVIDENCE SECTION

At the annual meeting of the Section, held on May 19, officers for the ensuing year were elected as follows: Frederick C. Williams, Chairman; Howard W. Congdon, Vice-Chairman; and William R. Benford, Secretary-Treasurer. Following the business meeting, Clarence W. Hudson, consulting engineer of New York City, gave an illustrated address on the proposed Narragansett Bay Bridge.

SPOKANE SECTION

At the regular monthly meeting of the Section, held May 13, Storey Buck, a Spokane member of the Washington State Legislature, was the speaker. He discussed various legislative matters of interest to all present.

ST. LOUIS SECTION

At the regular monthly luncheon meeting of this Section, held on April 25, A. P. Greensfelder reported on the initial convention of

the Construction League of the United States, recently held in St. Louis. He spoke of the auspicious start made by this organization and of its objects and activities, and also called attention to the formation of the St. Louis Building Congress. This was followed by an address by Lt. Col. E. L. Daley, Corps of Engineers, U.S.A.

About 40 members and guests attended the regular monthly luncheon meeting of the St. Louis Section, held at the Hotel Mayfair on May 23. Various business matters were transacted, and there were several four-minute talks on the steps being taken by the American Legion in St. Louis to relieve the depression. Baxter L. Brown gave a brief talk on the meeting of the Administrative Board of Engineering Council, held in Washington on May 13.

Texas Section

The spring meeting of the Texas Section, for which most original and attractive advance notices were sent out, was held in Austin on April 15 and 16. The meeting was called to order by T. E. Huffman, president of the Section, and Mayor P. W. McFadden, of Austin, gave the address of welcome, which was responded to by O. H. Koch.

The first paper was delivered by Dean T. U. Taylor, of the University of Texas, on the subject, "The Silting of Lake Worth." At the conclusion of this, Herbert S. Crocker, President of the Society, was introduced and told of the Society's work. Following this, H. L. Schiflet, student member of the University of Texas Chapter, who spent two years with the United Fruit Company in Guatemala, delivered a paper entitled "The Banana Engineer."

After luncheon, Carlton Adams, a member of the architect firm of Adams and Adams, gave an interesting extemporaneous discussion on the details of the design of the new state highway building. This was followed by a similar discussion by Stanley P. Finch on the new engineering building of the University of Texas. A very interesting paper on "Re-Surveying Land West of the Pecos" was then read by W. J. Powell, and the last technical paper was presented by W. C. Youngs, of the Research Division of the State Highway Department, who gave a very detailed discussion of recent researches of concrete aggregates.

On Saturday the convention closed with an all-day inspection trip to the Darragh quarries and the Hamilton Dam Power Project between Burnet and Llano. There were 250 visiting engineers and their wives who were entertained there by F. A. Dale, Texas manager of the project, and the staff of the Central Texas Hydro-Electric Company, owners of the dam project. Luncheon was served in the mess hall of the Fegles Construction Company, contract builders of the dam.

Toledo Section

During the past year the Toledo Section has sponsored various interesting illustrated lectures on technical subjects. Among these was a talk on the manufacture of steel given by Mr. Richardson, of the Bethlehem Steel Company, at a meeting of the Section held on March 2. Members of the Ohio Northern University Student Chapter were guests of the Section on May 3, when an inspection trip was made to the Libby Glass Manufacturing Company and the Willys-Overland Company. Luncheon was served at the University of Toledo.

Student Chapter News

Agricultural and Mechanical College of Texas Student Chapter

Meetings held by the Agricultural and Mechanical College of Texas Student Chapter during the past year were addressed on a wide range of engineering subjects, which included: "Timber Preservation," "Lining of Irrigation Ditches," "Concrete Construction," and "Aerial Surveying." These meetings were enthusiastically attended. The membership of the Chapter is 64.

Antioch College Student Chapter

Numerous social as well as business meetings were listed in the annual report of the Antioch College Student Chapter. On one occasion, Prof. Carl A. Norman, of the engineering faculty of Ohio State University, spoke on the place of an engineer in society. Inspection trips were made to the plants of the Southwestern Portland Cement Company of Osborn, Ohio, and of the Hooven, Owens, Rentschler Company of Hamilton, Ohio.

Brooklyn Polytechnic Institute Student Chapter

An annual report from the Brooklyn Polytechnic Institute Student Chapter indicates that meetings held during the year were interesting and well attended. Among the speakers were: Ralph W. Atwater, Construction Manager of the Merritt-Chapman and Scott Company, whose subject was "River Piers for the Bucksport, Me. Bridge"; Dr. D. B. Steinman, of Robinson and Steinman, who spoke on the "Design and Construction of the St. Johns Bridge"; and Linton Hart, consulting engineer with Gow and Company, who chose as his subject "Foundations and Driving Caissons." On November 27 a trip was taken to the Kensico Dam and Reservoir.

Bucknell University Student Chapter

During the past year the Bucknell University Student Chapter has held a number of very interesting meetings. Inspection trips were taken to the new Federal penitentiary at Lewisburg, Pa., and to the Pennsylvania Department of Highways Testing Materials Laboratory and Department of Hydrography.

California Institute of Technology Student Chapter

Five regular meetings comprised the past year's activities of this Chapter. Interesting talks were given at each meeting, and among the speakers were: F. D. Bowlus, who spoke on the "Engineering Work of the U.S. Forest Service"; A. L. Sonderegger, president of the Los Angeles Section; and H. P. Gillette, who spoke on "Weather Cycles and Their Causes." At the April meeting a motion picture of the "Development of the Los Angeles Harbor" was shown.

Carnegie Institute of Technology Student Chapter

Members of this Chapter held numerous meetings during the past year at which many subjects of engineering importance were discussed. Speakers at these meetings included: Lewis McIntyre, Traffic Engineer of Pittsburgh; Nathan B. Jacobs, vice-president of the Morris Knowles Company, Inc.; Thomas Fitzgerald, vice-president and general manager of the Pittsburgh Railways Company; and Alexander V. Karpov, Designing Engineer of the Aluminum Company of America.

Case School of Applied Science Student Chapter

Frequent meetings of this Chapter have been held throughout the school year. Among the speakers on various occasions were: Mr. Blaser, Chief Engineer of the Cleveland Railway Commission; Mr. Bigelow, of the Union Terminal Construction Company; and R. L. Harding, of Wilbur Watson and Associates.

Clemson Agricultural and Mechanical College of South Carolina Student Chapter

Among the interesting subjects discussed at the meetings held by this Student Chapter during the past year were: "The Westchester County Park System," "The Holland Tunnel," "Mississippi River Flood Control," and the "Bacteria Content in Water." This Chapter has 22 members.

College of the City of New York Student Chapter

Members of the College of the City of New York Student Chapter have had an interesting year. Speakers at some of their meetings were: Ole Singstad, noted tunnel engineer and authority; John R. Slattery, Deputy Chief Engineer of the Board of Transportation; D. B. Steinman, consulting engineer, Robinson and Steinman; Capt. Wilhelm Neiman; and E. A. Prentis, of Spencer, White, and Prentis.

Columbia University Student Chapter

Among the activities participated in by members of the Columbia University Student Chapter were an illustrated lecture and a dance given during the spring semester. The lecture, which was given by Mr. Stearns, of the Port of New York Authority, was illustrated by moving pictures of the erection of the George Washington Bridge.

Cooper Union Student Chapter

Interesting programs comprised the meetings held during the past year by the Cooper Union Student Chapter. Among the speakers on these occasions were: Robert Ridgway, Chief Engineer of the Board of Transportation, who spoke on the "Boulder Dam Development"; and D. B. Steinman, who gave a talk on the

"Architectural Aspects in Bridge Design." At the last meeting, held on April 13, a motion picture entitled "The Arteries of Industry" was shown.

DELAWARE UNIVERSITY STUDENT CHAPTER

A number of interesting talks were heard by the members of this Chapter at monthly meetings held throughout the past year. Among the speakers were: Mr. Barnholt, safety engineer for the E. I. du Pont Company, who spoke on "Safety Engineering"; Harry Maier, engineer for the Wilmington Water Department, who chose as his subject "Wilmington's New Sewage Plant"; A. W. Stephens, consulting engineer from New York City, who spoke on "Construction of the Brooklyn Army Base"; and S. T. Pollock, of the Century Wood Preserving Company, who gave an interesting talk on "Creosoting."

DREXEL INSTITUTE STUDENT CHAPTER

Meetings of this Chapter were held frequently during the past year; and many of them were addressed by student members who gave exceptionally interesting talks. Among the visiting speakers were B. F. Hastings, who chose as his subject "Wind Stress Computation"; S. C. Clark, who spoke on "Oxy-Acetylene Welding"; and C. A. Emerson, Jr., who gave a talk on "Water Works and Water Purification."

GEORGIA SCHOOL OF TECHNOLOGY STUDENT CHAPTER

Many interesting talks were heard by those who attended the frequent meetings held by this Chapter during the past year. Speakers on some of these occasions were: Frederick H. McDonald, who spoke on "The Economic Problems of Modern Engineering"; H. D. Mendenhall, consulting engineer, who chose as his subject, "The Examination and Licensing of Engineers by Laws Authorized and Enforced by State Government"; and Prof. C. M. Strachan, head of the Civil Engineering Department of the University of Georgia, who spoke on "The Construction of Low-Cost Roads." On November 13, the Chapter joined with the Georgia Section in honoring Francis Lee Stuart, then President of the Society, and George T. Seabury, Secretary, at a formal dinner dance. Addresses were given by Mr. Stuart and Mr. Seabury.

HARVARD UNIVERSITY STUDENT CHAPTER

The Harvard University Student Chapter held 10 meetings during the past year. On Friday, October 9, Henry Goldmark, consulting engineer, gave an illustrated talk on the design and construction of the Panama Canal; and on March 15, Lazarus White, president, Spencer, White, and Prentis, Inc., gave an illustrated talk on the foundations for the Bank of Manhattan Building in New York City.

IOWA STATE STUDENT CHAPTER

After the summer vacation, meetings of the Iowa State Student Chapter were resumed on October 2, at which session Franklin Thomas, of the California Institute of Technology, spoke on "The Colorado River Aqueduct Project." On January 19, John Fassbinder gave an illustrated talk on the Holland Tunnel, and Homer Scott addressed the meeting on February 23 on "The Muscle Shoals Hydro-Electric Development." Motion pictures of road construction were furnished by the Caterpillar Tractor Company for the meeting held on April 22, and a talk by Professor Von Tunglen, of the Sociology Department, on "Human Engineering" was the feature of the last meeting held on April 27.

JOHNS HOPKINS UNIVERSITY STUDENT CHAPTER

Membership in the Johns Hopkins University Student Chapter numbers 30. Meetings were held frequently during the year, and very interesting talks were given. A special meeting held on November 12 was addressed by Francis Lee Stuart, then President of the Society, and Secretary Seabury.

KANSAS STATE COLLEGE STUDENT CHAPTER

An annual report from the Kansas State College Student Chapter indicates that meetings held during the semester were well attended. On December 3, J. C. Geiger, superintendent of construction, Kansas Gas and Electric Company, spoke on experiences in engineering practice. At the February 4 meeting, H. F. Hemker, sales manager for the General Electric Company, Kansas City, Mo., spoke on the "Fundamental Theory of Vacuum Tubes and Their Application in Industry"; and on April 7, A. P. Learned, consulting engineer, Black and Veatch, spoke on "Natural Gas."

LEHIGH UNIVERSITY STUDENT CHAPTER

During the school year there were five meetings of the Student Chapter of Lehigh University. Guest speakers at these meetings were: Prof. E. H. Rockwell, of Lafayette College; Arthur G. Hayden, designing engineer of the Westchester County Park Commission; Wilson T. Ballard, vice-president of J. E. Greiner Company of Baltimore; and S. A. Thorsen.

MANHATTAN COLLEGE STUDENT CHAPTER

According to the annual report there are 80 members in the Student Chapter of Manhattan College. At one of the six meetings held during the year, D. B. Steinman, consulting engineer and president of the State Board of Licensing Engineers, gave a talk on "Fifty Years of Bridge Building." There were 150 in attendance at this meeting.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY STUDENT CHAPTER

The Student Chapter of the Massachusetts Institute of Technology has had a number of interesting meetings during the past year. Among those who addressed these meetings were: Ernest R. Springer, Chief Engineer of the Boston Transit Department; E. H. Rogers, Chief Engineer of the Metropolitan Park Division; Francis Lee Stuart, Past-President of the Society; George T. Seabury, Secretary of the Society; and J. M. Barker, vice-president of Sears, Roebuck and Company. At the final banquet, held on May 4, addresses were made by J. Theodore Whitney, president of the Whitney Engineering Company; Frank E. Winsor, Chief Engineer, Metropolitan District Water Supply Company; and Prof. Charles M. Spofford.

MISSOURI SCHOOL OF MINES AND METALLURGY STUDENT CHAPTER

Meetings of the Student Chapter of the Missouri School of Mines and Metallurgy were held frequently throughout the semester. Among the speakers present on these occasions were: H. C. Beckman, district engineer, U.S. Geological Survey; Dean Anson Marston, College of Engineering, Iowa State College; and Maj. P. S. Reinecke.

MONTANA STATE COLLEGE STUDENT CHAPTER

Lectures given at the meetings of this Chapter included a most interesting group of subjects. Among these were geology, structural and highway engineering, the construction of a railroad bridge, and hydraulic engineering. The last meeting, held on May 26, was devoted to discussion of a thesis on bridge construction, written by two of the seniors.

NEWARK COLLEGE OF ENGINEERING STUDENT CHAPTER

Monthly meetings of this Chapter held during the past year offered very pleasing programs. Among the speakers heard on these occasions were: C. W. Dunham, of the Port of New York Authority; A. Bank, of the City of Newark Water Supply Department; Morris R. Sherrerd, Chief Engineer of the New Jersey Water Policy Commission; Lt. Richard Aldworth, manager of the Newark Airport; and A. H. Vey, of the New Jersey Traffic Commission. In November the Chapter inspected the Plainfield, N.J., Sewage Treatment Plant; and in March, the Chimney Rock triangulation system of the New Jersey Water Policy Commission.

NORTH DAKOTA STATE COLLEGE STUDENT CHAPTER

Among the informative talks given at the meetings of the Student Chapter of the North Dakota State College during the past semester was one by Mr. Macgowan, of the Universal Atlas Cement Company, who chose as his subject the "Romance of Concrete."

OHIO NORTHERN UNIVERSITY STUDENT CHAPTER

A number of the 46 members of the Ohio Northern University Student Chapter gave talks at various meetings held during the year. On May 12, R. M. Stohl, City Engineer of Bowling Green, Ohio, gave a talk on "Water Works and Water Purification"; and on January 26, an inspection trip was taken to the opening of the sewage disposal plant at Delphos, Ohio.

OHIO STATE UNIVERSITY STUDENT CHAPTER

Programs of exceptional merit were arranged for the meetings of the Ohio State University Student Chapter during the past year. On November 23, Ole Singstad, Chief Engineer and Superintendent of the Holland Tunnel, spoke at some length concerning different phases of the operation and construction of the tunnel. Approximately 140 persons attended this lecture. "The Work of the Sanitary Engineer" was the subject chosen by Harrison P. Eddy, consulting engineer, for the April 6 meeting, at which there were about 150 present.

OREGON STATE AGRICULTURAL COLLEGE STUDENT CHAPTER

Interesting talks were given at the meetings of the Oregon State Agricultural College Student Chapter during the past year. Among those who spoke were: Roy A. Klein, state highway engineer of Oregon, who discussed the road-building process in Oregon; J. C. Stevens, of Stevens and Koon, consulting engineers, who gave a talk on the construction of the Eugene Municipal Power Plant; and Harry D. Freeman, of Bartholomew and Associates, City Planning and Landscape Engineers of St. Louis, who spoke concerning the proposed city plan which his firm was making for Portland, Ore.

PENNSYLVANIA MILITARY COLLEGE STUDENT CHAPTER

During the past year inspection trips were taken by the members of this Chapter to the Eddystone Sewage Disposal Plant, the Chester Water Works Plant, the Sun Shipbuilding Company, and the Baldwin Locomotive Works. On January 8, R. R. Metheany, maintenance-of-way engineer, Pennsylvania Railroad, spoke on the electrification of the Pennsylvania Railroad; and on March 11, Robert Haig, vice-president of the Sun Shipbuilding Company, spoke on shipbuilding and engines. Seminar talks given by the seniors were presented to all but the freshman class and at various times movie reels, borrowed from the U.S. Bureau of Mines, were shown.

PENNSYLVANIA STATE COLLEGE STUDENT CHAPTER

At the meetings held by this Chapter during the past year, many interesting subjects were discussed. Among these were: "Modern Highway Construction" and the "Relation of the Contractor to Civil Engineering."

PRINCETON UNIVERSITY STUDENT CHAPTER

The Princeton University Student Chapter has held four meetings during the past year. At one of these, C. E. MacQuigg, manager of the Union Carbide and Carbon Research Laboratories, gave a talk on "Some Contributions of the Metallurgist to Modern Engineering Development."

PURDUE UNIVERSITY STUDENT CHAPTER

During the past year various interesting engineering programs have been presented by this Chapter. Among those who addressed the meetings were: Professor Babbitt, of the University of Illinois, who gave an illustrated lecture of a tour that he made through Japan and China; Prof. W. J. Henderson, of Purdue University, who gave an illustrated description of the arch bridge across the Grand Canyon; and Dr. Milo Ketchum, of the University of Illinois, who addressed the meeting held on April 14 on the "Frontier of Engineering." At the last meeting, held on April 21, F. S. Serviss, of Purdue University, spoke on the "Geological Considerations Involved in Water Supply."

RENSSELAER POLYTECHNIC INSTITUTE STUDENT CHAPTER

A number of well known engineers spoke at the different meetings of the Rensselaer Polytechnic Institute Student Chapter held throughout the year. Among them were: D. B. Steinman, consulting engineer of New York City; Prof. Earl Church, Associate Professor of Photogrammetry, Syracuse University; Glenn S. Reeves, engineer of port development and transit work; James W. Rickey, Chief Hydraulic Engineer for the Aluminum Company of America; and Clarence W. Dunham, Assistant Engineer, Designing Division, Port of New York Authority. These meetings were very well attended.

ROSE POLYTECHNIC INSTITUTE STUDENT CHAPTER

Six meetings of unusual interest have been held during the year by the Rose Polytechnic Institute Student Chapter. Among the speakers were: Charles E. Piety, of Terre Haute, and F. E. Strouse, special representative of the Pennsylvania Railroad. On several occasions interesting lantern slide lectures were given.

RUTGERS UNIVERSITY STUDENT CHAPTER

The first meeting of this Chapter, held on January 14, was addressed by F. W. Skinner, consulting bridge engineer, who spoke on "The George Washington Bridge." The meetings which followed were addressed by the following visitors: Col. George L. Watson, consulting engineer for the Port of New York Authority; Arthur G. Hayden, Design Engineer of the Westchester County Park System; T. G. Neuber, Railway Maintenance Engineer of the New York Central Lines; and B. B. Williams, engineer with the Port of New York Authority.

SOUTH DAKOTA STATE SCHOOL OF MINES STUDENT CHAPTER

At the annual banquet which was held by this Chapter on May 25, a talk on "The Problems of a City Manager," was given by E. M. Sneckenberger, city manager of Rapids City. A number of motion pictures were shown during the year, among them being pictures on the development of public roads in the national parks, the construction of the Lee's Ferry Bridge, bituminous road surfacing, including the various methods used in practice, and pictures on concrete highways and vitrified brick paving. An inspection trip was taken by the seniors to Orman Dam, near Belle Fourche, S.D., on May 16. The trip also included a visit to the hydro-electric plant at Spearfish, S.D.

STANFORD UNIVERSITY STUDENT CHAPTER

The report of the Stanford University Student Chapter indicates that it has held numerous interesting meetings during the past year. On January 27, H. H. Hall, Chief Engineer of the Standard Oil Company of California, spoke on "The American Society of Civil Engineers' Aims and Activities"; on February 6, A. P. Davis spoke on "Engineering in Soviet Russia and Turkestan"; and on April 19, M. P. O'Brien, Associate Professor of Mechanical Engineering at the University of California, gave an illustrated talk on the "Use of Models in Hydraulic Laboratories."

UNIVERSITY OF CALIFORNIA STUDENT CHAPTER

A number of interesting programs have been given at the meetings of this Chapter held during the past year. Among the speakers on various occasions were: R. E. Davis of the faculty, who spoke on "The Engineering Materials Testing Laboratory, Its Equipment and Experimental Work"; Fred C. Scobey, Senior Irrigation Engineer with the U.S. Department of Agriculture, whose talk on "New Conduits and Unusual Flow Conditions" was illustrated with lantern slides; and Harry Goodridge, City Engineer of Berkeley, whose subject was "Duties and Problems of the City Engineer in the City-Manager Type of Government." In addition to these meetings, there were trips to the Southern Pacific Creosoting Plant on the Oakland Pier and to the Oakland-San Francisco Bay Bridge borings and barges.

UNIVERSITY OF NORTH CAROLINA STUDENT CHAPTER

Frequent meetings of the William Cain Civil Engineering Society of the University of North Carolina Student Chapter have been held throughout the school year. These have been very interesting as well as instructive. Some of the speakers were: Francis Lee Stuart, Past-President of the Society; George T. Seabury, Secretary of the Society; Prof. A. C. Howell, who read a paper on "A College in Utopia"; and Dr. W. F. Prouty, of the Geology Department, who gave a talk on the "Formation and Characteristics of Mountains."

VILLANOVA COLLEGE STUDENT CHAPTER

The Villanova College Student Chapter has had a successful and interesting year. Inspection trips were taken to the Conowingo Hydro-Electric Power Plant, the Pennsylvania Railroad Terminal, the Wissahickon Bridge, the new branch of the Broad Street Subway, and several other points of interest in and around Philadelphia. Lectures were heard by Prof. C. D. Cook, a member of the civil engineering faculty, and Daniel McQuaid, of the Taylor Instrument Company. On December 1, a film entitled "Hydro-Electric Power Production in the New South" was shown, and at the January meeting a slide lecture was given on "Filtration."

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for August

AMONG the articles to appear in the August issue of CIVIL ENGINEERING will be one containing a valuable discussion of the relationship of factors affecting the flow of water in open channels and in distorted scale models. The authors, Herbert D. Vogel and John Paul Dean, are both officers in the Corps of Engineers. Because of their close contact with the U.S. Waterways Experiment Station at Vicksburg and the problems of the Mississippi River Commission, they may be considered experts in the use of models to predict the behavior of a hydraulic system from a small-scale model of that system.

Water supply engineers will be interested in the problem of the city of Clinton, Okla., which required additional water and found that the most feasible source was in need of treatment. After a study of comparative costs, the engineers proposed that a hollow overflow dam be built to impound the needed water and that the purification works be installed within the dam itself. The reasons leading to this decision and the details of the installation will be explained in the August issue in an article by Calvin V. Davis and Franklin Hudson, Jr., Associate Members Am. Soc. C.E.

The New Jersey Agricultural Experiment Station maintains a department of sewage research, of which Dr. Willem Rudolfs, M. Am. Soc. C.E., is chief. Here experimental determination has been made of the amount of radiation and other heat losses from sludge tanks in order to learn whether the amount of gas produced by the digestion of sludge in a tank is sufficient to raise and keep the sludge at the temperature required for thermophilic digestion. In an article to appear in the August issue, Dr. Rudolfs and H. J. Miles, Jun. Am. Soc. C.E., will present the results of this interesting study.

Steel Bridges Awarded Prizes

WINNERS of the annual prizes offered by the American Institute of Steel Construction for the most beautiful steel bridges opened to traffic during 1931 were recently announced. In Class A—structures costing over $1,000,000—the jury selected the Bayonne Bridge over the Kill van Kull between Bayonne, N.J., and Port Richmond, Staten Island, N.Y. It is the longest steel arch bridge in the world, exceeding but slightly the Sydney Harbor Bridge, Australia. Built at a cost of $16,000,000 by the American Bridge Company for the Port of New York Authority, this 1,675-ft. arch was opened for traffic on November 15, 1931. O. H. Ammann, M. Am. Soc. C.E., is Chief Engineer of the Port of New York Authority.

In Class B, for bridges costing between $250,000 and $1,000,000, the prize was awarded to the Waldo-Hancock Suspension Bridge, which was built over the Penobscot River, at Bucksport, by the American Bridge Company for the State of Maine. The design was made by Robinson and Steinman, Members Am. Soc. C.E., consulting engineers. This structure has a main span of 800 ft. and cost $846,000.

Another New England bridge won an award, the Class C prize for bridges costing less than $250,000. It is the structure over the Connecticut River at West Stewartstown, N. H., built by the American Bridge Company from the plans of the New Hampshire State Highway Department. This deck arch structure has a span of 136 ft. and was built at a cost of $45,000. Photographs of these prize bridges are featured on a page at the beginning of this issue.

In each class a second choice, or honorable mention, was made. The Maumee River Suspension Bridge, built at a cost of $3,000,000 for the city of Toledo by McClintic-Marshall from plans by Waddell and Hardesty, Members, Am. Soc. C.E., consulting engineers, received the second place in Class A. Its main span of 875 ft. is flanked by two side spans of 204 ft. each.

In Class B, the second choice went to the steel arch over Croton Lake, New York, designed by Howard C. Baird, M. Am. Soc. C.E., consulting engineer for the Westchester County Park Commission, of which Jay Downer, M. Am. Soc. C.E., is Chief Engineer. This 750-ft. span was built by the Mount Vernon Bridge Company at a cost of $821,000.

Second choice in Class C was awarded to the 108-ft. Afton Overhead Bridge in Union County, Iowa, built at a cost of $27,000. It was designed under the direction of the Iowa State Highway Commission, and fabricated by the American Bridge Company.

All these bridges are highway structures, although provision has been made in the Bayonne Bridge for the possible future addition of rapid transit lines. The jury of award consisted of Raymond Hood, architect; F. O. Dufour, M. Am. Soc. C.E., consulting engineer of Philadelphia; Dr. L. C. Dillenbeck, of the School of Architecture, Columbia University; C. T. Bishop, M. Am. Soc. C.E., of the Sheffield Scientific School, Yale University; and A. L. Kocher, managing director of *The Architectural Record*.

AFTON OVERHEAD BRIDGE—HONORABLE MENTION, CLASS C
A Grade Separation in Union County, Iowa

MAUMEE RIVER BRIDGE—HONORABLE MENTION, CLASS A
The City of Toledo, Ohio, Opened this $3,000,000 Bridge in November 1931

CROTON LAKE ARCH—HONORABLE MENTION, CLASS B
Built for the Westchester County (N.Y.) Park Commission Over the Reservoir of the New York Water Supply

High Lights of a Trip to Hoover Dam

By M. M. O'SHAUGHNESSY
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, SAN FRANCISCO

IT WAS with pleasure that on Saturday night, May 28, I left San Francisco on the six o'clock train for Mojave, Colo., where I arrived in 12 hours, thence taking an automobile and driving for 5 hours due east 248 miles, to Boulder City, Nev. The road from Mojave passes through Barstow where it joins the California State Highway extending to the Nevada state line, 43 miles south of Las Vegas. Driving over this smooth asphalt road in an automobile presents quite a contrast to the wagon trip in clouds of alkali dust I took over the state road of 34 years ago between Randsburg and Reno. The present road traverses, generally, a desert region, full of sand and gravel, which make excellent material for road construction. The state is making the most of this road-bed by keeping it well oiled, so that our car made 70 miles an hour with ease.

OILED GRAVEL HIGHWAY ACROSS THE DESERT

FILTER PLANT FOR BOULDER CITY'S WATER SUPPLY

Along the road from Barstow to the dam is a pole line of the California-Nevada Power Company, which carries electrical energy for all kinds of construction purposes. The price paid by the contractor to the utility is 6 mills per kilowatt-hour for construction purposes, and 6 cents per kilowatt-hour for lighting purposes. There is added a further $200,000 a year as a stand-by charge. It is computed that in six years the $200,000 a year will reimburse the company for the capital outlay.

A MADE-TO-ORDER CITY

Boulder City, the construction-camp town for Hoover Dam, is located on a desert plateau 2,500 ft. above the sea, and is occupied by about 5,000 inhabitants—men, women, and children, most of whom are employees of the Six Companies, which have the contract for the completion of the Hoover Dam. The central part of the town is paved with asphalt. The buildings are mostly of temporary frame construction, equipped for fire fighting, and are nearly all air cooled, so that the temperature generally is not unpleasant. It is considerably cooler than in the bed of the canyon, at the actual dam site. Three conspicuous buildings have been erected in Boulder City, the United States Veterans' headquarters, the moving picture house, and a church.

CONCRETE PLANT FOR HOOVER DAM

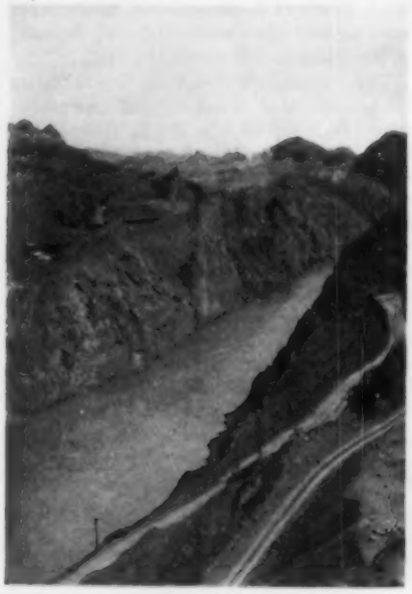
An extensive commissary department, which occupies two buildings, each 50 ft. wide and 150 ft. long, has been established. Each of these buildings will seat 550 men. The kitchen is located between the two buildings, and the most approved machinery for dish-washing is employed. It would do a housewife's heart good to see how the dirty dishes are put on the chain belt, which conveys them to a scouring and washing machine, so that they come out clean at the other end.

Belting may be said to play an indispensable part in the construction operations. Down near the dam, large rubber belts 32 in. wide, 1 in. thick, and 760 ft. long, are used to convey the gravel and sand from the dumps up to the mixing plant on top of a very large steel structure. Motor trucks with a capacity of 14 cu. yd., liquid measure, are used for transporting materials out of the tunnels and distributing rock on the waste piles. The motor vehicles, which are in general use all over the project, give evidence of the progress made during the last 20 years as applied to construction methods.

PLAN MAKING

The making of plans for this dam was a unique undertaking. The difficult part was to handle the floods of the Colorado River. This is a body of water 300 ft. wide. The day I was there, May 29, it carried 103,000 sec-ft. of water having a depth of 28 ft. and a velocity of 11 ft. per sec. In order to construct a dam it is necessary to take this great body of water out of the river bed and pass it around the dam site through the mountains on each side. Tunnels Nos. 1 and 2, on the Nevada side of the river, and Nos. 3 and 4, on the Arizona side,

Looking Upstream



Looking Downstream

THE DAM SITE, MAY 29, 1932, FROM THE NEVADA SIDE

have all been excavated in solid lava rock weighing 151 lb. per cu. ft. Strange to say, it did not take one stick of timber to keep the rock from spalling from the roof on the heads of the miners. These tunnels are excavated to a diameter of 56 ft. and are being lined with 3 ft. of concrete to make a clear inside diameter of 50 ft.

The flow of the river fluctuates widely. In June and July it may reach 150,000 sec-ft., whereas the rest of the year the normal flow is 10,000 sec-ft. The level of the tunnels is about 20 ft. below the elevation of the present water surface and to deflect the water in the river into the tunnels it will be necessary to construct diverting dams. The four tunnels are more than adequate in size to carry 150,000 sec-ft. of water. A large enough plant has been provided by the contractors so that the lining of the four tunnels will be completed by October of this year. The next problem will be to construct a diverting dam to deflect the water, and this, it is hoped, will be completed during the coming winter season.

When I was there, 1,520 men were employed at the site, but at the peak period of tunnel excavation last year 3,500 were at work. The climate is excellent the year round, except that in July and August it is extremely hot. The men all seem to be happy and in a healthy condition.

AMPLE TRANSPORTATION FACILITIES

The Union Pacific has built a branch railway 22 miles long from Las Vegas to Boulder City. The United States Government constructed 10½ miles of track from Boulder City to the Nevada Canyon wall above the crest of the projected dam, at a cost of $650,000, and also built the 7-mile highway from Boulder City to the crest of the dam. The contractors constructed a road from this highway to a point on the river below the dam, as well as 21 miles of standard-gage railway connecting the Government line through Hemenway Wash north of the dam down to the river bank and to the excellent gravel deposits on the Arizona side above the dam.

The contractors now have fine facilities for transporting the 5,000,000 cu. yd. of gravel that will go into the concrete of the dam. The gravel is all loaded by steam shovel on to railway cars, transferred across the bridge, and hauled to within a mile of the dam, where it is separated and washed. It is graded into four sizes: sand, pea gravel, gravel below 3 in., and small boulders 9 in. and under. The Colorado River is so loaded with mud that in its natural condition it is not even suitable for washing gravel, but when free from sediment and cooled, it makes a soft, delicious drinking water.

The mechanical problem of handling material for the concrete, at the rate of 15,000 cu. yd. a day, will be such that the contractors can permit no breakdown in the transportation system. It was estimated that 3,400,000 cu. yd. of concrete will go into Hoover Dam proper and the balance of the materials into tunnels, power house, and auxiliary structures. So far, the contractors are ahead of their time schedule by 8 months and if appropriations by the Government are made, there is no reason why they should not have this structure finished well ahead of the designated time.

FINANCES INTERESTING

The total construction bid is $48,890,995.50. Appropriations so far amount to $31,660,000, of which $13,285,000 is the estimated cost of the tunnel excavation. The contractors must have reaped a rich harvest on this preliminary work, which offered every opportunity for economical mining. The Government furnishes all supplies, including the cement and materials required.

Most of the contractors on this project have done work under my direction at different times. Together they make a very strong combination and feel entirely confident that they will finish the job.

There are several elements interested in this development: the people who are paying the bills; the contractors who are doing the work; the United States Government; the states of Arizona and California, which may get water and power below the dam; the borderland in Mexico, which will receive the surplus water; and Imperial Valley, which will be protected from flood and supplied with water for irrigation.

Los Angeles is confronted with the greatest problem in carrying its part of the Colorado River through the mountains from an intake at Parker, above Yuma, Ariz. The people voted $220,000,000 in bonds to build 265 miles of aqueduct, which includes 93.7 miles of tunnels. This water is obtained at a low level from the Colorado River and will all have to be de-silted and pumped to an elevation of 1,523 ft. to penetrate the ridge between Los Angeles and the Colorado River.

The people of San Diego have a well defined plan for bringing the water over at a lower level, with more water at lower unit costs. The selection of the route may possibly be made within the next year.

BUILT ON GOVERNMENT CREDIT

It does not matter much what method is used for disposing of the water, but both the water and the hydro-electric energy developed will have enough value in a period of 50 years to entirely reimburse the Government for lending its credit to the project. The estimated cost of the Boulder Canyon power development, including interest, is $126,500,000. Under present economic conditions in southern California the value of Boulder Canyon power is determined not by the cost of competitive hydro-electric power, but by the cost of producing power in large steam generating units located at tidewater and operating on fuel oil or natural gas. It will take 280 miles of pole lines to reach the load centers of southern California. Transmission will be at 220,000 volts.

The estimated cost of the completed dam and reservoir, exclusive of interest, is $70,600,000, and the estimated annual cost of operation and maintenance, $317,000. It is computed that the annual cost of storage water will be 62 cents per acre-foot. The suggestion was made that 50 or 60 cents per acre-foot would be a reasonable charge for the Government to make for water.

It is safe to assume that the income for both water and power will be adequate to repay the cost of the project to the Government, which simply lends its credit to a great enterprise that will redound to the prestige and glory of the United States.

Honorary and Advanced Degrees Conferred

IT IS interesting to note that schools and colleges throughout the country are more and more coming to realize the importance of engineering achievement by awarding honorary and advanced degrees to engineers who have made outstanding contributions to the profession. During the 1932 commencement season several members of the Society were among the engineers thus honored. Doubtless there are others of whom the Society has not heard.

The following items have been taken from press clippings:

FRED C. CARSTARPHEN, M. Am. Soc. C.E., Doctor of Engineering, Colorado School of Mines (first earned doctorate in engineering conferred by this institution).

JOHN J. DONOVAN, M. Am. Soc. C.E., Doctor of Engineering, Worcester Polytechnic Institute.

ALFRED D. FLINN, M. Am. Soc. C.E., Doctor of Engineering, Worcester Polytechnic Institute.

ROBERT E. HORTON, M. Am. Soc. C.E., Doctor of Science, Albion College.

DUGALD C. JACKSON, M. Am. Soc. C.E., Doctor of Science, Columbia University.

DAVID A. MOLITOR, M. Am. Soc. C.E., Doctor of Engineering, George Washington University (conferred at its bicentennial celebration on February 22, 1932).

NEWS OF ENGINEERS

From Correspondence and Society Files

DONALD H. MCNEAL has been made vice-president and general manager of the National Homes Finance Corporation of Chicago. He was previously a merchandising consultant with offices in Chicago.

H. H. WATSON, former general superintendent of construction for the San Diego Consolidated Gas and Electric Company, is now serving the Northern States Power Company in the same capacity.

EVERITT W. WILSON has been appointed assistant-director general of the Southern State Railways of Persia. Until recently, Mr. Wilson was foreign representative for the Winston Brothers Company of Minneapolis.

PAUL F. LOEHLER has opened offices in Washington, D.C., as a consulting engineer.

C. W. LOVELL has become connected with the Underwriters Service Corporation of Louisville, Ky., after resigning his position as Chief Engineer and Sales Manager of the Kentucky Consolidated Stone Company, also of Louisville.

GEORGE MILLER WELLS, president of the Union Sulphur Company of New York, was previously president of the Solvay Process Company of that city.

MAURICE B. FROST is now connected with the Greenwich Water Company of Greenwich, Conn.

CHARLES S. BILYEU has resigned his position as manager of the Structural Materials Department of the R. W. Hunt Company of Chicago, and is now employed by Robinson and Steinman of New York.

WILLIAM G. WOOLFOLK has been recently appointed president of the Detroit City Gas Company.

M. L. KAUFMAN, formerly architect and engineer, Berlinger and Kaufman, Inc., with offices in New York, has taken a position with the National Screen Service, Inc., of that city.

FRANCISCO PONS has been named Commissioner of the Interior for the Island of Porto Rico.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From May 10 to June 9, 1932

ADDITIONS TO MEMBERSHIP

BAIRD, GORDON GIFFORD (Jun. '32), Asst. Engr., Grade I, Oneida County Dept. of Highways (Res., 1661 Steuben St.), Utica, N.Y.

BALABAN, EDWARD (Assoc. M. '32), Pres., Balaban-Gordon Co., Inc., 1457 Broadway, New York, N.Y.

BARNETT, FRANCIS VICTOR (Jun. '32), Draftsman, United Gas System, Box 1349, Monroe, La.

BARTLEY, ROBERT JOHN (M. '32), Civ. Engr., 28 Lawrence Lane, Bay Shore, N.Y.

BLODGET, LORIN THEODORE (Assoc. M. '32), S. W. Cor. 12th St. and 68th Ave., Oak Lane, Philadelphia, Pa.

BRODKIN, NATHAN DANIEL (Assoc. M. '32), Structural Designer, Board of Transportation, 250 Hudson St. (Res., 3400 Wayne Ave.), New York, N.Y.

BROWN, ANDREW ALBERT (Jun. '32), Draftsman, L. L. Jenison (Res., 406 Ruffner Ave.), Charleston, W.Va.

BURN, PARIS RUSSELL (Assoc. M. '32), Gen. Mgr., Hayner & Burn, Las Cruces, N.M.

CONTRATTO, JAMES (Jun. '31), 3915 Waverly Ave., East St. Louis, Ill.

COTT, WILLIAM BELLMAN (Jun. '32), 182 Westwood Ave., Akron, Ohio.

DAVIS, JOHN SWIFT (Jun. '31), 1512 Baltimore Trust Bldg., Baltimore, Md.

DEUTSCH, CHARLES PAUL (Jun. '31), 388 Fairview Ave., Fairview, N.J.

DHILLON, ARJAN SINGH (Jun. '32), 332 East Madison St., Ann Arbor, Mich.

DOWNING, CHARLES JACKSON (Jun. '31), Wentworth, N.H.

DRENNAN, WALLACE CAMPBELL (Jun. '32), Field Engr., Road Dept., New Orleans Public Service, Inc., 503 Cherokee St., New Orleans, La.

EAGAR, ROBERT JOSEPH (Assoc. M. '32), Engr. and Surv., 217 West 125th St., New York, N.Y.

EDWARDS, ROBERT FIELDING (Assoc. M. '32), Asst. Engr., Transit Bureau, City of Newark, Newark (Res., 82 Watchung Ave., Chatham), N.J.

FISCHER, ALBERT PAUL (Jun. '31), 1501 North 26th St., Philadelphia, Pa.

GARDNER, KENNETH ELMER (Jun. '32), 407 Pontiac Ave., Brooklyn, Baltimore, Md.

GILDERSLEEVE, THOMAS DUANE (Jun. '31), 421 Shelby St., Live Oak, Fla.

GOLZÉ, ALFRED RUDOLF (Jun. '32), Asst. Engr., Bureau of Valuation, Interstate Commerce Comm. (Res., 3039 Macomb St., N.W.), Washington, D.C.

HARRIS, RICHARD JOHN (Jun. '31), 934 South 6th St., Terre Haute, Ind.

HORAM, CHARLES RAYMOND (Assoc. M. '31), Asst. Civ. Engr., Airways Div., U.S. Dept. of Commerce, Hotel Washita, Cordell, Okla.

HUTCHINSON, RALPH WHITE (Jun. '32), Asst. Constr. Engr., Bridge Dept., State Div. of Highways, 804 California State Bldg., Los Angeles (Res., 1227 North Maryland St., Glendale), Calif.

JONES, JIM D. (Jun. '32), R.F.D. 2, Rives, Tenn.

KHOSLA, AJUDHIA NATH (M. '32), Executive Engr., Panjnad Weir Div., S.V.P., P.O. Panjnad, Bahawalpur State, Punjab, India.

LAIDLAW, DOUGLAS STAUNTON (Jun. '32), Draftsman, Beauharnois Constr. Co., Box 50, Beauharnois, Que., Canada.

LANNING, FULTON (Assoc. M. '31), Abbott Court, North, Apartment C-20, Radburn, N.J.

LOFFLAND, MURREL EDWARD (Jun. '32), Junior Engr., State Dept. of Public Works and Bldgs., Div. of Highways (Res., 415 East Court St.), Paris, Ill.

MILLER, LEO MARC (Assoc. M. '32), Civ. Eng. Designer, Met. Water Dist. of Southern California, 306 West 3d St., Los Angeles, Calif.

MULHOLLAND, JACK (Jun. '31), Lecturer in Eng., Univ. of Queensland, Brisbane, Queensland, Australia.

NEES, LOUIS AUGUST, JR. (Jun. '31), 799 Main St., North Bergen, N.J.

OSBORNE, EDWARD GLENN (Assoc. M. '32), Res. Engr., State Dept. of Highways (Res., 4259 Winslow Pl.), Seattle, Wash.

PAGET, FREDERICK HILTON (Assoc. M. '32), Asst. Engr., State Dept. of Public Works (Res., 504 Twenty-First St.), Sacramento, Calif.

QUIRICONI, EUGENE (Jun. '32), Structural Steel Draftsman, Grade 3, Board of Transportation, 250 Hudson St. (Res., 27 Bedford St.), New York, N.Y.

SEDER, WILLARD JAMES (Assoc. M. '32), Mgr., Rankin Works, McClintic-Marshall Corp., Pittsburgh (Res., 623 Greendale Ave., Edgewood), Pa.

SETHMANN, MARTIN WILLIAM (Jun. '32), Eng. Asst., Board of Transportation, New York (Res., 1717 Gates Ave., Brooklyn), N.Y.

SHANE, HENRY KAMSLER (Assoc. M. '32), Junior Engr., Hydr. Div. Missouri River Impvts. (Res., 3214 Bellefontaine), Kansas City, Mo.

SHARKEY, FRED JOHN (Assoc. M. '31), City Engr., (Res., Columbia Hotel), Wenatchee, Wash.

SHIH, KONG HUAI (Assoc. M. '31), Care, Chinese Consulate, 69 Ridge Hill, London, N.W. 11, England.

STOKES, CHARLES ERIC (Jun. '32), 1749 L St., Fresno, Calif.

THOMPSON, ISADORE (Jun. '31), Draftsman, Austin M. Hill (Res., 2807 Inez St.), Los Angeles, Calif.

THOMSON, MEDFORD THEODORE (Assoc. M. '32), Asst. Engr., U.S. Geological Survey, Water Resources Branch (Res., 4716 Fifteenth St., N.W.), Washington, D.C.

WEINSTOCK, ISIDOR LAWRENCE (Jun. '32), 1402 Ave. K, Brooklyn, N.Y.

WHEATON, HERBERT HUDSON (Assoc. M. '32), 2336 Channing Way, Berkeley, Calif.

WILEY, CHARLES WATSON (Jun. '31), 55 Windsor Ave., Allwood, N.J.

MEMBERSHIP TRANSFERS

ABBOTT, RUSSELL WARD (Jun. '27; Assoc. M. '32), 36 Trowbridge St., Cambridge, Mass.

BRUNER, EDWIN LEWIS (Assoc. M. '20; M. '32), Vice-Pres. and Treas., Grant & Bruner, Ltd., 607 Ferguson Bldg., Los Angeles, Calif.

CLARK, KENNETH MILES (Jun. '29; Assoc. M. '32), Asst. Engr., Met. Drainage Comm., 2694 University Ave., St. Paul (Res., 3645 Sixteenth Ave., South, Minneapolis), Minn.

CLOGSTON, PERLEY WALTER (Jun. '30; Assoc. M. '32), Chf. of Survey Party, Marc Eidlitz & Son, 70th St. and York Ave. (Res., 565 Academy St., Apartment 5), New York, N.Y.

FARWELL, HERBERT FREEMAN (Jun. '24; Assoc. M. '32), Asst. Supt., Kalman Floor Co., Watertown (Res., 88 Sycamore St., Roslindale), Mass.

FEAGIN, LAWRENCE BAKER (Jun. '24; Assoc. M. '32), Engr., U.S. Engr. Office, 927 Volunteer Bldg., Chattanooga, Tenn.

FEER, HUGO ANTHONY (Jun. '24; Assoc. M. '32), Engr., Great Northern Paper Co. (Res., 459 Penobscot Ave.), Millinocket, Me.

GARDNER, RUSKIN TENNEY (Jun. '27; Assoc. M. '32), Asst. Supt., Water Dept., City of Phoenix, City Hall, Phoenix, Ariz.

MACY, GLENN DAVIS (Assoc. M. '24; M. '32), Engr. in Chg., Dist. 2, State Highway Dept., Box 785, Roswell, N.M.

MESSER, MERTON WILLIAM (Jun. '31; Assoc. M. '32), 3 Broadway, Concord, N.H.

MORRISON, DEMING WILLIAM (Jun. '25; Assoc. M. '32), Asst. Hydr. Engr., Div. of Water Resources (Res., 1801 T St.), Sacramento, Calif.

RAEDER, ELMER WARREN (Assoc. M. '28; M. '32), Asst. Prof., Dept. of Civ. Eng., Univ. of Colorado, Boulder, Colo.

ROYER, ROBERT STUART (Assoc. M. '12; M. '32), Pres., R. Stuart Royer, Inc., 207 Builders Exchange Bldg., Richmond, Va.

SEXTON, CLARENCE WILLIAM NEWSOME (Assoc. M. '25; M. '32), Senior Lecturer, Civ. Eng., Univ. of Melbourne, Carlton, N 3 (Res., 79 St. Helens Rd., Hawthorn East E-3), Victoria, Australia.

VELZ, CLARENCE JOSEPH (Jun. '26; Assoc. M. '32), Chf. Engr., F. J. Oleri, 650 Bergenline Ave., West New York (Res., 2411 Hudson Terrace, Coytesville), N.J.

WILLIAMS, HOWARD JAMES (Assoc. M. '27; M. '32), Asst. Engr., Fay, Spofford & Thorndike, 44 School St., Boston, Mass.

REINSTATEMENTS

MANTON, ARTHUR WOODROFFE, M., reinstated May 31, '32.

RESIGNATIONS

BELL, GEORGE EDWARD, Assoc. M., resigned June 6, '32.

BIGELOW, WALTER BELL, Jun., resigned May 26, '32.

BROUSSEAU, GEORGE FRED, Jun., resigned May 13, '32.

BRUUN, AAGE, Jun., resigned May 31, '32.

COGSWELL, ROBERT COMAN, Assoc. M., resigned May 24, '32.

CONNET, OLIVER WESTON, M., resigned May 19, '32.

HALLIDY, ROBERT JAMES, M., resigned May 31, '32.

PINCHOT, GIFFORD, Affiliate, resigned June 7, '32.

VAUGHN, FRANK K., M., resigned May 21, '32.

DEATHS

BRANNE, JOHN SEVERIN. Elected Assoc. M., Oct. 5, 1898, M., July 9, 1912; died May 25, 1932.

DATE, LOUIS CHRISTIAN. Elected Assoc. M., June 30, 1911, M., Mar. 2, 1915; died May 20, 1932.

EHLE, BOYD. Elected Assoc. M., Jan. 3, 1894, M., Feb. 1, 1910; died June 5, 1932.

FRUSTEL, ROBERT MAXIMILIAN. Elected Assoc. M., Nov. 4, 1914; died May 8, 1932.

JONES, WILLIAM HENRY. Elected M., May 4, 1904; died Apr. 22, 1932.

PARSONS, WILLIAM BARCLAY. Elected Jun., June 7, 1882, M., Nov. 2, 1887, Hon. M., Nov. 16, 1925; died May 9, 1932.

RHODIN, CARL JONAS. Elected M., Dec. 3, 1912; died May 3, 1932.

ULRICH, WILLIAM LEROY. Elected M., Dec. 4, 1922; died May 27, 1932.

WELLS, GEORGE EDWARD. Elected Assoc. M., Feb. 6, 1912; died May 26, 1932.

TOTAL MEMBERSHIP AS OF JUNE 9, 1932

Members	5,862
Associate Members	6,391
Corporate Members	12,253
Honorary Members	17
Juniors	2,965
Affiliates	122
Fellows	5
Total	15,362

Men Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 97 of the 1932 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

CONSTRUCTION

SUPERINTENDENT OF CONSTRUCTION; M. Am. Soc. C.E.; 39; married; university graduate; 14 years experience in building construction; 3 years in designing; 8 years as superintendent. Foundations, underpinning, industrial plants, and factory and office buildings. Able executive and excellent organizer. Available now. Location Pacific coast preferred. D-936-325-A-6 San Francisco.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; 6 years experience on hydro-electric construction, steam plant and substation improvement, transmission right-of-way surveys, and general surveying including topography. Desires position with consulting engineer; also interested in public utility and construction. Salary secondary to opportunity. Prefers location in United States. D-588.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 31; university graduate; single; 8½ years experience; design and construction of sewerage systems, sewage disposal works, irrigation, drainage, and municipal improvements. Highway location and construction. Good practical electrical and mechanical experience. Foreign language, Spanish. Location immaterial. C-8421.

HIGHWAY ENGINEER; Assoc. M. Am. Soc. C.E.; 29; married; experienced in highway location and bridge and road construction. Available at once for any offers where these qualifications might prove an asset, such as contractor's estimator, superintendent, or sales representative. C-6901.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 40; married; 14 years experience in highway construction, electrical and mechanical installations, valuation, and appraisal. As resident engineer, constructed large concrete and hydraulic-fill dam. Engineer on three large hydro-electric dams; 1 year teaching. Accustomed to handling men. Desires position. Available immediately. Location immaterial. D-975.

DESIGN

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; B.S. degree; Michigan registration. Design and construction of roads, pavements, sewers, water works. Past 10 years in industrial work; buildings; roasting and smelting furnaces; transportation of materials; structural steel; concrete foundations. Capable of taking charge of drafting room. B-768.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; graduate of University of Michigan; New York license; 1 years experience detailing, design, and field work with contractor; 2 years as chief inspector of municipal contracts, also design and surveying; 3 years in design and supervision of buildings, retaining walls, etc., with public service corporation. Any location. Available immediately. D-942.

CIVIL AND HYDRAULIC ENGINEER; Assoc. M. Am. Soc. C.E.; 34; married; honors graduate and Ph.D.; 9 years broad experience in investigation, design, and construction of hydro-electric, irrigation, water supply, and general engineering works; original research on dam design; also administration of large works. Has traveled abroad extensively. D-281.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate; 2 years experience designing highway bridges; 3½ years designing parkway bridges—rigid frame type and skew and square crossings; last 1½ years in charge of squad; 1 year reinforced concrete construction; 2½ years hydraulic investigations; 6 months valuation; 1½ years on irrigation project as hydrographer and computer. C-3595.

EXPERIENCED DESIGNER ON WATER WORKS AND SEWERAGE; Assoc. M. Am. Soc. C.E.; member of A. W. W. A.; 37; married. Has been with some of the leading sanitary engineering firms in this country in responsible charge of design. C-6422.

CIVIL AND STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 28; B.C. in C.E. and C.E. degrees; about 5 years experience in New York City as a designer, detailer, draftsman, checker, and estimator of steel and reinforced concrete. References and samples of work sent on request. C-6186.

STRUCTURAL ENGINEER AND DRAFTSMAN; Assoc. M. Am. Soc. C.E.; 5 years experience as a structural draftsman and 17 years experience as a structural engineer, in charge of design and field supervision for architects, on all classes of structural steel and reinforced concrete buildings. Will consider position of any kind. D-1022.

DESIGNING ENGINEER; Assoc. M. Am. Soc. C.E.; 39; married; C.E. degree; 18 years experience surveying, estimating, inspecting, designing, and detailing of structural steel and reinforced concrete. Plant layout, office, or field work. Available immediately. D-1028.

STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 30; single; graduate of Rensselaer Polytechnic Institute; 2 years field experience in railroad maintenance of way; 5 years experience in drawing office of steel fabricators. Desires position with firm of structural engineers, contractors, or fabricators. Available at once. Location immaterial. C-9493.

DRAFTSMEN

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 32; married; experienced structural designer and checker; also topographical drafting experience. Would accept part-time work. Acquainted with New York City departments—Water Supply, Gas, and Electric; Board of Water Supply; Board of Transportation; Department of Docks, Plants, and Structures. Good contact man for contractor. C-4281.

EXECUTIVE

CIVIL ENGINEER; M. Am. Soc. C.E.; 43; married; B.S., LL.B.; member Massachusetts Bar; licensed engineer four states; unusual structural design and executive experience on offices, college buildings, factories, warehouses, industrial plants, gypsum and paper mills, waterfront construction, and bridges. Sometime instructor in evening engineering schools. Desires connection with engineer or in engineering college. B-1600.

CIVIL ENGINEER; M. Am. Soc. C.E.; experienced in design, investigation, and construction of irrigation projects in Russia, Mexico, and United States. C-5854.

ENGINEER; Assoc. M. Am. Soc. C.E.; licensed; 21 years experience; rapid transit, heavy industrial construction, paper mills, slaughter houses, bakeries, cold storage plants, power plants; office manager, specification writer, purchasing agent; familiar all codes; can handle construction and maintenance of large industrial concern, manage office for architect, engineer, or contractor, contact clients. Permanency desired. D-932.

SANITARY AND MUNICIPAL ENGINEER; M. Am. Soc. C.E.; 50; married; graduate civil engineer; licensed New York; 27 years experience (including 23 years in responsible charge) on water supply, filtration, and sewage disposal plants, both design and construction; also some teaching experience; will accept any position for which training and experience qualify. B-2535.

MUNICIPAL AND SANITARY ENGINEER; M. Am. Soc. C.E.; married; graduate civil engineer; 15 years experience in design and supervision of construction dams, water works, sewage disposal plants, paving, storm drainage, sewerage and water systems, plumbing installations, inspections, reports, and appraisals. Present chief engineer, secretary, and treasurer of consulting engineering firm. Location immaterial, if position is permanent. D-251.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 34; married; licensed professional engineer, New York State; graduate in architecture, Cooper Union; studied civil engineering for 3 years; specialized in stress analysis, deflections in trusses, arches, portals, and indeterminate structures; largely experienced in wind bracing (including earthquake) in tall office buildings of steel and reinforced concrete. Available at once. A-4136.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience in drafting, design, and construction; estimates, inspection, surveys, layouts, and related work. Capacity to assume responsibility. Desires connection with construction company, consult-

ant, contractor or architect in field or office; also sales-engineering or instructorship. C-2605.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; B.E. in C.E. from Vanderbilt University; 1 year as instrumentman with the Tennessee Department of Highways; 2 years as instrumentman and 2 years as resident engineer with firm of consulting engineers and architects in field and office. Desires contracting, engineering, or manufacturing connection. Available immediately. D-989.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; French; 5 years experience in the United States on subway construction, caisson work, subaqueous tunnels, underpinning and foundations, and reinforced concrete. About to sail for France; could accept technical or commercial mission in France; well introduced in French contracting business and public utilities. References. C-4546.

INDUSTRIAL AND CIVIL ENGINEER; M. Am. Soc. C.E.; graduate. Over 20 years experience covering investigations, reports, and appraisal work, and organization and supervision of office and construction forces. Design and construction of chemical and other industrial plants, hydro-electric developments, housing groups, water and sewer systems, and other underground utilities. B-2835.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; C.E. degree; New York license; 17 years experience in construction, design, and layout of industrial plants, copper refineries, smelters, furnaces, heavy machinery, structural steel, and foundations. Can take full charge of drafting room and get work out economically. B-5715.

CIVIL ENGINEER; M. Am. Soc. C.E.; 42; married; graduate; 20 years engineering experience—including municipal, railroad, water supply, general construction, teaching, and supervision of office and field forces. Responsible connection with public utility, contractor, consulting engineer, or university desired. Location and salary open. Available immediately. D-1023.

CIVIL AND MINING ENGINEER; Assoc. M. Am. Soc. C.E.; 33; married; technical graduate; registered; 12 years experience in sanitary, municipal, street, pavement, highway, coal mining, and irrigation work. Experience covers design, construction, supervision, and superintendence, including preliminary investigations and reports. Seeks connection in any engineering capacity. Location immaterial. Available immediately. D-947.

JUNIOR

YOUNG CIVIL ENGINEER; Jun. Am. Soc. C.E.; graduate; experience covers irrigation, inspection, surveying, drafting, computing, estimating, and design. Desires affiliation on a hydraulic project. Open to foreign engagement. Highest references available. C-9801.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; graduate of Rensselaer Polytechnic Institute, 1930; C.E. degree; 1½ years sales experience; desires position with construction company or in any civil engineering work; salary and location secondary. Available immediately. D-949.

CIVIL ENGINEERING GRADUATE; Polytechnic Institute of Brooklyn, 1932; desires work in engineering office as structural or topographical draftsman, computer, surveyor, or in any other position available. Salary not important; willing to work for experience. New York location preferred. Will travel if necessary. References. D-969.

GRADUATE; Jun. Am. Soc. C.E.; 25; married; B.S. (C.E.), 1930; employed 2 years by large manufacturing company, which afforded an opportunity to learn cooperation with other people to accomplish a set purpose. Have had experience in tunnel work; familiar with pneumatic machinery and blasting. Will consider any location. Available on short notice. D-979.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; graduate of Stanford University, 1931; major, hydraulic engineering; also studied accounting and liberal arts. Opportunity desired in public utilities field or banking, with emphasis upon chance to learn these two fields of work. Good references. Available July 1. Location immaterial. D-984-317-A-4 San Francisco.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; graduate of the College of the City of New York; C.E. degree; 1 year on line and grade and construction of subaqueous compressed air tunnel; 1 year estimating on subway construction; 1 year teaching surveying. Desires any engineering position. Location immaterial. D-971.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; B.S. in C.E. from Purdue University, 1931; 1 year of experience in welding research and development and mathematical analysis of welded structures. Desires work in any branch of civil engineering. Available immediately. Location immaterial. References sent on request. D-1009.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; graduate of Bucknell University, 1931; experience in highway location, profile and mass diagram. Desires position with contractor, railroad, industry, or university in any engineering capacity. Good college record and references. Salary secondary. Location immaterial. C-9685.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; B.S. in C.E. from Yale University; 1 year of experience on construction of water power and supply system; 3 years on railroad maintenance work. Desires opportunity in any civil engineering work. Interested in teaching. Location immaterial. D-1008.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; B.S. in C.E., 1927; 4½ years experience in railroad structures, hydro-electric developments, and industrial buildings. Available immediately. Location anywhere. D-372.

GRADUATE; Jun. Am. Soc. C.E.; 23; married; graduate of Yale University and Massachusetts Institute of Technology; 1½ years experience in surveying. Available immediately. Location immaterial. D-1050.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 32; married; graduate; 8 years experience with large construction company on reinforced concrete and finished type structures; accounting, cost, testing, subcontracts, and superintendent; 5 years renting and maintaining real estate while at college. Desires connection in construction or allied fields or real estate. B-8171.

MISCELLANEOUS

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 18 years experience estimating and constructing buildings; is establishing a manufacturers' agency in central West Virginia; would like to hear from reputable manufacturers of building products and equipment who wish representation in this territory. D-1049.

SALES

STRUCTURAL ENGINEER EXECUTIVE; M. Am. Soc. C.E.; 45; married; over 15 years general experience in directing sales and engineering operations of modern structural steel fabricating business. Well acquainted with district sales in Western Pennsylvania and Ohio. Has specialized in efficient handling of estimating department. C-5095.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 42; with established sales office in Cleveland, Ohio, handling building products and specialties involving engineering features, would like to secure one or two additional agency accounts for northern Ohio representation. D-1024.

TEACHING

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 30; college graduate with B.S. and M.S. degrees; 6 years in general contractor's office—estimating, designing, drafting, field supervision, cost keeping, and buying. Knowledge of and experience in bookkeeping. Also experience in highway and sewer work. Will accept work of any kind, anywhere. Good references. C-1.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; New York State license. Wide experience as engineer and executive in heavy construction, harbor works, investigation, and reports. S.B. from Massachusetts Institute of Technology, supplemented this year at Columbia University by complete review in class of basic subjects in civil engineering and observation of teaching methods. C-1689.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 30; B.S. in engineering at Princeton University, 1926; New York State license. Desires teaching position. Author of several technical papers. Unusual background of underpinning, subway, and heavy construction work. Formerly chief assistant to well known consulting engineer. Interested in experiments with earth pressures. C-9232.

GRADUATE IN CIVIL ENGINEERING; Assoc. M. Am. Soc. C.E.; married; ex-instructor in hydraulics, strength of materials, surveying, mill buildings, water power laboratory, and in evening school in estimating. Experience also in construction on mill factory, bank, hospital, office, and residence buildings both in office and in field. Desires teaching position anywhere. C-3237.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1932. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

AMERICAN SOCIETY FOR TESTING MATERIALS. INDEX TO PROCEEDINGS, V. 26–30, 1926–1930. Philadelphia, American Society for Testing Materials, 1932. 251 pp., 9 × 6 in., cloth, $1.75 and half leather, $2.75 to members; cloth, $2.50 and half leather, $3.50 to non-members.

This full subject and author index to these volumes of the *Proceedings* of the society will be welcomed by all those interested in the testing of materials and the study of their properties. It supplements the index to the first 25 volumes which appeared some years ago.

BARRAGES CONJUGUÉS ET INSTALLATIONS DE POMPAGE. By G. Laporte. Paris, Gauthier-Villars et Cie, 1932. 144 pp., diagrs., charts, tables, 10 × 7 in., paper, 35 frs.

The economic possibilities of increasing the output of hydro-electric plants by pumping water back into storage reservoirs with off-peak power are investigated here, especially for the case of two or more plants installed upon a river and operated together. Various feasible plans of pumping are discussed, and the characteristics of the pumping plants suited to each are determined.

EARTH DAM PROJECTS. By J. D. Justin. New York, John Wiley & Sons, 1932. 345 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $5.

Principles of design and construction that will be useful to the engineer, and the application of these principles by concrete examples. Description of a number of dam failures and discussion of the causes. Preliminary investigations and surveys, subsurface investigations, and materials and laboratory tests. The various methods of building and a number of representative dams are described, and numerous details of construction are discussed.

FARADAY AND MAXWELL. (*Deutsches Museum Abhandlungen und Berichte, Jahrg. 4, Heft 1*). By E. Cohn. Berlin, VDI-Verlag, 1932. 29 pp., illus., diagrs., 8 × 6 in., paper, 90 rm.

The centenary of Maxwell's birth and Faraday's great discovery occurred in 1931. This essay links the lives and work of these geniuses in a most interesting way, showing how our present conception of the principle of energy evolved from Faraday's experiments through Maxwell's studies.

FIELD MANUAL FOR BRIDGE INSPECTORS. Prepared by S. S. Steinberg. Baltimore, Maryland State Roads Commission, 1932. 122 pp., diagrs., charts, tables, 8 × 5 in., cloth, gratis.

Good practice in bridge construction and inspection, advice on handling emergencies during construction, and other information of use in the field are here set forth in considerable detail. The book, which is a general supplement to the plans and specifications for any particular bridge, will guide the inspector in the correct performance of his duties.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

BASCULE, MAINTENANCE AND REPAIR. Arresting Abutment Shifting on Bascule Bridge. O. H. Pilkey. *Eng. News-Rec.*, vol. 108, no. 20, May 19, 1932, pp. 725 and 726. Base extensions and struts used to eliminate vertical and horizontal movement of abutments of Summit St. Bridge in Toledo, Ohio.

CONSTRUCTION. Steel Delivery Barge Serves as Falsework in Erecting Bridge Span, S. Butler. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, p. 686. Construction of steel truss bridge, with maximum span of 200 ft., over the Quachita River at Sterlington, La.; a barge, 26 ft. wide, 175 ft. long, and 10 ft. deep, contained all the steel for the four-span bridge, so loaded that erection could be carried on from east to west.

FLOORS. Paving Washington Street Memorial Bridge, Wilmington, Del., A. P. Shaw. *Pub. Works*, vol. 65, no. 5, May 1932, pp. 40 and 42. Method of construction of brick and tar-sand pavement of concrete arch bridge consisting of five spans, with a total length of 720 ft. and 40-ft. clear roadway, center lane of which is occupied by a double line of trolley tracks.

KILL VAN KULL. Design, Materials, and Erection of Kill van Kull (Bayonne) Arch, L. S. Moisseiff. *Franklin Inst.—Journal*, vol. 213, no. 5, May 1932, pp. 465–502, 4 supp. plates. Preliminary studies in design and tests made in connection with construction of the famous Kill van Kull Bridge, described in many previously indexed articles; comparative study of suitable types of bridges; observations on test model.

MASONRY. Effect of Backing on Masonry Arches, G. H. Hargreaves. *Surveyor*, vol. 81, no. 2100, Apr. 22, 1932, pp. 433–435. Object of backing; moments and thrusts due to side loading; maximum live load moments and corresponding thrusts at crown and at springing.

STRENGTHENING. Reconstruction of Attock Bridge Over Indus. *Engineering*, vol. 133, no. 3461, May 13, 1932, pp. 561–563, 2 supp. plates. Original bridge had length of 1,412 ft. between abutments; girders made of 30-ton steel, supported on steel trestle piers; plan adopted was to convert each of the existing 257-ft. spans into a pair of continuous girder spans, by establishing a new pier under each at mid-length; main spans were replaced by new girders, 304 ft. long between bearings. See also Engineering Index 1931, p. 172.

WELDING. Altering Wrought Iron and Steel Bridges by Welding, F. P. McKibben. *Am. Welding Soc.—Journal*, vol. 2, no. 3, Mar. 1932, pp. 21–25. Causes of alterations; corrosion; cracks due to overloading or to defective metal; replacing corroded bases by welding; readjustment of existing members; reinforcement for flanges of stringers and floor beams of Chicago's Great Western Railway bridges; devices for shortening inactive eye-bars in pin-connected trusses. Before Am. Road Builders' Ass'n.

BUILDINGS

CHICAGO MERCHANDISE MART. Largest Building in World, F. F. Sengstock. *Universal Engr.*, vol. 55, no. 4, Apr. 1932, pp. 25–29. Statistical details of 18-story building with 20,000 ft. of floor space per story, together with a 6-story tower; characteristics of power plant equipment and operation.

CONSTRUCTION. Pre-Fabricated Buildings Will Bring Lower Costs, A. T. North. *Am. Architect*, vol. 141, no. 2607, May 1932, pp. 66 and 67 and 90. Pre-fabrication of steel houses; pre-fabricated steel units of the dome of the Travel and Transport Building at Chicago World's Fair.

STEEL, CONSTRUCTION. Derrick Travelers Adapted to Steel-Frame Building Erection. *Eng. News-Rec.*, vol. 108, No. 19, May 12, 1932, pp. 692–694. Erection of steelwork for Inland Terminal No. 1 of the Port of New York Authority in New York City; the building, which is sixteen stories high, covers the entire block between 15th and 16th sts., Eighth and Ninth aves., and is 800 × 206 ft. in plan; travelers and derricks combined in erection plan; ten floors of steel were placed by jumping travelers only once; traveler design and operation.

CITY AND REGIONAL PLANNING

BUILDING HEIGHTS. Control of Elevations in Practice, P. H. Warwick and J. T. Johnson. *Surveyor*, vol. 81, no. 2101, Apr. 29, 1932, pp. 455–456. Case of control; difficulties; method of control; power of persuasion; Winchester subcommittee; successful operation. Before Town Planning Inst.

DEVELOPMENT. America Tomorrow, F. L. Wright. *Am. Architect*, vol. 141, no. 2607, May 1932, pp. 16 and 17 and 76. General survey of the present economic system with special reference to traffic problems of metropolitan districts; centralization is no longer practical.

CONCRETE

ADMIXTURES, CELITE. Effect of Celite on Modulus of Elasticity of Concrete, G. A. Smith. *Am. Concrete Inst.—Journal*, vol. 3, no. 9, May 1932, pp. 613–626. Results of series of tests showing that the use of celite for promoting workability can have no appreciable effect on the modulus of elasticity or on the strength of the concrete.

AGGREGATES. What Water-Cement Ratio Theory Means to Aggregate Producer, F. H. Jackson. *Rock Products*, vol. 35, no. 4, Feb. 27, 1932, pp. 47–49. Quality of aggregates an important factor; flexural strength is the basis of pavement design; durability; technic of water-cement ratio trial method; practical limitations; economic aspects of method. Before Nat. Sand and Gravel Ass'n.

BEAMS, CONCRETE. Effect of Time Loading Upon Bond Stress Between Concrete and Steel, R. L. Brown and E. C. Clark. *Am. Soc. Testing Materials—Proc.*, vol. 31, part 2, 1931, pp. 690–700 (discussion), 701 and 702. Tests made in 1929 demonstrated the feasibility of testing reinforced-concrete beams under sustained loading and of testing several beams simultaneously with one load-holding rig; after the adhesive resistance between concrete and steel had been overcome, a further margin of strength was provided by sliding resistance.

DURABILITY. Performance of Concrete in Exposed Structures, E. Viens. *Am. Soc. Testing Materials—Proc.*, vol. 31, part 2, 1931, pp. 725–744 and (discussion), 835–840. Uniformity and homogeneity, which are the most necessary features if building material is to be durable, can be secured through care in preparing aggregates, proportioning, mixing, transporting, placing, and proper curing; considerations in securing durable concrete.

FROST EFFECT. Resistance of Concrete to Frost Action, F. H. Jackson and G. Werner. *Am. Concrete Inst.—Journal*, vol. 13, no. 2, Apr. 1932, pp. 32–37 and (discussion) 37–38. Results of investigation begun 6 years ago for determining how the resistance of concrete to frost action is affected by the character of the coarse aggregate used in the mixture; sodium-sulfate soundness and freezing tests on coarse aggregates; effect of alternate freezing and thawing on flexural strength of concrete.

GRAVEL. Production of Aggregates from River Gravels in Plains Region—I, J. H. Ruckman. *Rock Products*, vol. 35, no. 8, Apr. 23, 1932, pp. 20–23. History of region and its effect on commercial problems; geological history of the peculiarities of raw materials and what is required of them to meet modern specifications. (Continuation of serial.)

HIGH GRADE. Advantages in Use of High Strength Concretes, T. T. Towles. *Am. Concrete Inst.—Journal*, vol. 3, no. 9, pp. 607–612. Use of concrete of a strength very much in excess of the commonly accepted standards of today in arch construction, beam construction, and in succession of spans.

MIXING. Coordination of Basic Principles of Concrete Mixtures—I, J. A. Kitts. *Concrete*, vol. 40, no. 5, May 1932, pp. 7–9. First article of series; importance of absolute volume; erroneous results from bulk and weight measures; Feret law of mixtures. (Continuation of serial.)

ROADS AND STREETS. Laying Ready-Mixed Concrete Highway. *Can. Engr.*, vol. 62, no. 17, Apr. 26, 1932, pp. 9–11. Description of the transit-mix system employed in laying 9 miles of concrete road between Atwood and Kennicott, Ont.; compressive strength of 1:2:3 ready-mixed concrete made by transit system.

SEWERS, CONCRETE. Concrete in Old Outfall Sewer in Good Condition After Twenty Years, M. J. Ruark and C. E. Keefer. *Eng. News-Rec.*, vol. 108, no. 20, May 19, 1932, p. 721. No disintegration of concrete discovered in Baltimore outfall sewer after service of 20 years; strength of concrete specimens taken from outfall sewer.

STIRRUPS. Spacing of Vertical Stirrups in Reinforced Concrete Beams, V. A. Malmberg. *Concrete*, vol. 40, no. 4, Apr. 1932, pp. 32–34. Presentation of tables and a diagram which utilizes the relation between stirrup spacing and the number of stirrups as counted from the point of zero shear.

WEATHERING. Weathering Tests Procedures for Concrete, F. H. Jackson. *Am. Soc. Testing Materials—Proc.*, vol. 31, part 2, 1931, pp. 789–794 and (discussion) 835–840. Freezing and thawing tests, heat tests, and sodium-sulfate tests. Bibliography.

CONSTRUCTION INDUSTRY

COSTS. Construction News Summary. *West. Construction News and Highway Builder*, vol. 7, no. 8, Apr. 25, 1932, pp. 236, 238, 240, and 242. Unit costs bid on bridge construction, water supply systems, tunnel construction, and street and road work in California and Nevada.

Current Construction Unit Prices. *Eng. News-Rec.*, vol. 108, no. 17, Apr. 28, 1932, p. 638. Unit prices bid for Marseilles Dam in Illinois River; storm water sewer for Baltimore; concrete superstructure on crib and pile piers, Wisconsin.

STREET AND ROAD WORK. Unit Bid Summary. *West. Construction News and Highway Builder*, vol. 7, no. 9, May 10, 1932, pp. 272, 274, 276, 40, and 42. Unit costs bid on street and road work in California, Arizona, Utah, and Oregon.

DAMS

CALIFORNIA. Much Concrete Work in Earth-Fill Dam, H. L. Walton. *Concrete*, vol. 40, no. 5, May 1932, pp. 10 and 11. Procedure of making and placing concrete in facing slab, spillway, and valve tower of the Santiago Creek earth-fill dam, in Orange County, California.

EARTH, CONSTRUCTION. Constructing Santiago Creek Rolled-Earth Dam, C. R. Browning. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, pp. 682–684. Design and construction of rolled-earth dam, 130 ft. high in Orange County, California; placing 1,103,700 cu. yd. of fill is accomplished in four months by the concentration of motor equipment; use of belt conveyor for transporting materials; reservoir provides 26,000 acre-ft. of storage for joint irrigation use in southern California.

HYDRAULIC GATES. Lloyd Barrage and Canals. *Water and Water Eng.*, vol. 34, no. 405, Apr. 20, 1932, pp. 160–163. Sluice gates in barrage and canal; excavation and costs; output figures and working costs for Ruston-Bucyrus excavators and other excavating machines having buckets with capacity of from 1 to 8 cu. yd. (Continuation of serial.)

RESERVOIRS, CONCRETE. Okanogan Avenue Reservoir at Wenatchee, G. H. Miller. *West. Construction News and Highway Bldr.*, vol. 7, no. 9, May 10, 1932, pp. 263–267. Construction of 4-mg. Okanogan Avenue Reservoir; effect of adding 3,750 lin. ft. of 16-in. cast-iron mains to high-pressure supply service.

PENNSYLVANIA. Pennsylvania Builds Reservoir for Flood-Control and Park Use. *Eng.*

News-Rec., vol. 108, no. 19, May 12, 1932, p. 692. Construction of Pymatuning storage reservoir, at the head of the Shenango River in Crawford County, on the Pennsylvania-Ohio line: day labor constitutes an unemployment relief measure.

SPECIFICATIONS. Bulkhead and Stoney Gates and Hoists for Hoover Dam-Boulder Canyon Project Arizona-California-Nevada. *U.S. Dept. Interior—Bureau Reclamation—Specifications*, no. 533, 1932, 22 pp., 52 supp. plates. Specifications for delivery of two 50 by 50-ft. bulkhead gates, with gate frames, roller tracks, etc., two twin-cylinder hydraulic bulkhead gate hoists; two 50 by 35-ft. Stoney gates; and two electric motor-driven Stoney gate hoists.

FLOOD CONTROL

PREVENTIVE ACTION. Reducing Flood Menace by Preventive Action, C. A. Book. *Eng. News-Rec.*, vol. 108, no. 20, May 19, 1932, pp. 722 and 723. Steps can be taken at little or no cost to check the growth of hazards; publicity, administrative control, and long-range planning are essential elements.

FLOW OF FLUIDS

CONTROL. Flow Measurement and Control—XXV, M. E. Behar. *Instruments*, vol. 5, no. 4, Apr. 1932, pp. 93–106. Head meters; commercially available primary devices; Venturi devices; flow nozzle devices; orifice devices; flange connection assemblies; quick-change devices. (Continuation of serial.)

MEASUREMENT. Motion and Measurement of Fluids, G. S. Binckley. *West. Gas*, vol. 8, no. 5, May 1932, pp. 54–56. Historical review of measuring devices; graft and deceit by early Roman priests and contractors in the measurement of water; development of the Venturi tube system of measurement; formulas for calculation of flow through Venturi tube. Before Southern Calif. Meter Ass'n.

PIPES. Flow of Water in Pipes. *Concrete Building and Concrete Products*, vol. 7, no. 5, May 1932, pp. 102 and 103. Kutter's formula; influence of roughness of the surface of flows; recent determinations of Kutter's coefficient. (Continuation of serial.)

CLAY. Structure of Clay and Its Importance in Foundation Engineering, A. Casagrande. *Boston Soc. Civ. Engrs.—Journal*, vol. 19, no. 4, Apr. 1932, pp. 168–209 and (discussion) 209–221. Compressibility of clay; explanation of the structure of natural clay deposit; remolding effect of pile driving on structure of clay; settlement of buildings; excavation as insulation against vibrations; foundations necessary to ensure rigidity; observations on buildings. Bibliography.

RIVER CROSSING. Deep Open-Caisson Foundations for Transmission Towers. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, pp. 696 and 697. Towers, 453 ft. high, for 4,300-ft. transmission-line span across Mississippi River, founded on caissons sunk 110 ft. below bank level by open excavation; lower parts of tower framing arranged to provide portal bracing between cylinders.

WOOD, DECAY. Society Research, H. E. Sawtell. *Boston Soc. Civ. Engrs.—Journal*, vol. 19, no. 4, Apr. 1932, pp. 149–167. Review of engineering research done by the Boston Society of Civil Engineers and some of its members, with special reference to original studies on the effect of decay on structural timbers and on the classification of clay for densities, done by the firm of C. T. Main, Inc., of Boston, Mass.

HYDRAULIC ENGINEERING

HYDRAULIC LABORATORIES. National Hydraulic Laboratory—II, H. N. Eaton. *Mech. Eng.*, vol. 54, no. 5, May 1932, pp. 335–340. Details of supply and measuring basins, main flume, discharge tanks, and other features.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

FORESTRY, FRANCE. Afforestation Work in Central Plateau of France, with Some Notes on Work Undertaken at Military Camp of La Courtine, E. P. Stebbing. *Roy. Soc. Arts—Journal*, vol. 80, no. 4145, Apr. 29, 1932, pp. 582–608, including discussion and appendixes. Influence of forests on rainfall, water supplies, erosion, and inundations.

RAIN AND RAINFALL, MEASUREMENT. Rainfall—III. *Water and Water Eng.*, vol. 34, no. 402, Apr. 20, 1932, pp. 153–155. Exposure of rain gage; over-shelter of gage; over-exposure of gage; curve showing percentage of rainfall caught by gages at various heights above ground.

INLAND WATERWAYS

CANALS, LIGHTING. Welland Ship Canal Lighting, R. M. Love, M. B. Hastings, and G. F. Mudgett. *Illum. Eng. Soc.—Trans.*, vol. 27, no. 5, May 1932, pp. 443–458. Brief history of canal; physical data; lighting of locks, prisms, mooring galleries, and other portions of canal described and illustrated.

ST. LAWRENCE RIVER. Canada's Weal Not Fostered by St. Lawrence Waterway Plan, W. T. Jackman. *Ry. Age*, vol. 92, no. 15, Apr. 9, 1932, pp. 599–602. Cost estimates are too conservative; use by ocean ships not economical; no benefit to farmer; grain trade shifting to Pacific ports; should collect tolls to defray all costs. Before Toronto Ry. Club.

UNITED STATES. Louisiana and Texas Intracoastal Waterway, R. F. Fowler. *Military Engr.*, vol. 24, no. 135, May-June 1932, pp. 284–286. Description of the Louisiana and Texas Intracoastal Waterway which is to be a canal 9 ft. deep and 100 ft. wide, extending from the Mississippi River to Corpus Christi, Tex., a distance of 600 miles; description of the canal; Plaquemine and Harvey locks; Tidal Lock; railway bridges; dredging.

IRRIGATION

CANALS, DESIGN. Irrigation Distribution Channels, H. F. Byham. *Commonwealth Eng.*, vol. 19, no. 9, Apr. 1, 1932, pp. 311–313. Chart for use in designing and estimating cross-section areas, cubical contents, etc., of earthen channels.

LAND RECLAMATION AND DRAINAGE

CULVERTS, MOVING. Complete Bridge Moved 22 Miles, E. Witt. *Highway Engrs. and Contractor*, vol. 40, no. 7, Apr. 1932, pp. 29 and 43. Method and costs of moving corrugated iron pipe with a diameter of 108 in. to new location; salvage value of large corrugated iron pipe.

MATERIALS TESTING

CONCRETE AGGREGATES, WEATHERING. Weathering of Aggregates, L. O. Hanson. *Am. Soc. Testing Materials—Proc.*, vol. 31, part 2, 1931, pp. 775–788 and (discussion) 835–840. Progress report on work being carried on at the Materials Laboratory of the University of Wisconsin to determine weathering characteristics of certain rocks and mortars and to develop and investigate accelerated weathering tests, using sodium sulfate as destructive agent; results of tests.

MAGNETIC. Magnetic Testing of Iron and Steel, A. V. de Forest. *Iron and Steel Engr.*, vol. 9, no. 4, Apr. 1932, pp. 170–173 and (discussion) 173–176. Typical applications of magnetic testing with particular regard to Magnaflux method; use of specially prepared iron powder consisting of particles of oblong shape and insulated by non-magnetic coating.

METALS, PROPERTIES. Limitations of Our Fundamental Knowledge of Properties of Metals, F. O. Clements. *Metal Industry (Lond.)*, vol. 40, no. 12 and 13, Mar. 18, 1932, pp. 323 and 324 and Mar. 25, pp. 353 and 354. Problems in different fields of applied metallurgy illustrate the need for further research. Before Am. Soc. Testing Materials, Am. Inst. Min. and Met. Engrs., and Am. Welding Soc.

METALS TESTING. Some Principles of Testing—I, W. Rosenhain. *Metallurgist (Supp. to Engineer)*, Apr. 29, 1932, pp. 57–58. Fundamental principles involved; question of procedure which should be adopted to develop a system of testing on an entirely sound and logical basis.

PHOTO-ELASTICITY. Polarised Light and Its Applications to Engineering, E. G. Coker. *Metallurgia*, vol. 5, no. 30, Apr. 1932, pp. 189–194. Loaded transparent plate models of parts of machines are examined in polarized light and show internal stresses as they occur in the actual members; description of how these experiments provide solutions to problems, in some cases where theoretical analysis fails. Before Inst. Mech. Engrs.

SHEET STEEL, AGING. Aging of Sheet Steel, *Metallurgist (Supp. to Engineer)*, Apr. 29, 1932, pp. 62–64. While it has been abundantly demonstrated that appreciable changes may take place in physical properties of sheet steel when stored at room temperatures, causes giving rise to these changes have not been definitely established; phenomenon appears to be one of aging, but until substances giving rise to this effect are definitely identified, suggestion cannot be unreservedly accepted.

STEEL, PLASTICITY. Plasticity as Applied to Steel Products, A. Nadai. *Engrs' Soc. West. Pa.—Proc.*, vol. 48, no. 3, Mar. 1932, pp. 65–72 and (discussion) 72–79. Investigation of stress distribution and slip phenomena, with particular regard to cold or hot rolling, forging, and pressing operations; use of photo-elastic methods.

PORTS AND MARITIME STRUCTURES

CAISSONS, CONCRETE, REPAIR. Displaced Caissons Restored at Shimidzu Harbor, Japan, T. Simano. *Eng. News-Rec.*, vol. 108, no. 18, May 5, 1932, p. 648. 11,000-ton caissons shifted by earthquake were re-aligned and re-leveled under quay wall by reflotation.

DOCKS, LIVERPOOL. Dock Reconstruction at Liverpool. *Engineering*, vol. 133, no. 3459, Apr. 29, 1932, pp. 514 and 515. Scheme comprises a new wet dock with an area of over 7 acres and a quay length of 3,231 ft. to be known as Trafalgar Dock; bascule bridge, which provides communication with the west side of the dock, has a clear span of 60 ft. and carries a 24-ft. roadway with a 5-ft. causeway on each side; the superstructure is raised and lowered by electrically operated machinery.

MANAGEMENT. Management of Canadian Ports. *Can. Engr.*, vol. 62, no. 16, Apr. 19, 1932, pp. 21 and 44. Study of the administration of five Canadian ports, by Sir Alexander Gibb, recommends the abolition of harbor commissions in Halifax, St. John, Quebec, Montreal, and Vancouver, and the establishment of a central board at Ottawa.

QUAY WALLS, CONCRETE. Concreting Lake-front Wall at Milwaukee, J. D. Levin. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, pp. 703–704. Construction of 5,000 lin. ft. of reinforced concrete waterfront wall in lake-shore park development at Milwaukee, Wis., completed in 200 working days.

WOODEN. Reconstruction of Wharf at Kaslo, B.C., P. E. Doncaster. *Eng. Journal*, vol. 15, no. 5, May 1932, pp. 270–275. Rebuilding timber wharf at Kaslo, B.C., on westerly shore of Kootenay Lake; cost $39,700; creosoted timber piling; traffic surface; details of quantities and costs of major items; log of condition of piling, driven in 1913–1914, as found on demolition of structure in 1931; comparative ultimate costs of uncreosoted and creosoted timber wharf.

ROADS AND STREETS

ASPHALT. Construction of Cold-Mix Pavements. *Can. Engr.*, vol. 62, no. 19, May 10, 1932, pp. 19 and 20, 44–46, and 48. Characteristics of cold mixes and their employment in the construction of highways; classification of cold mixes; construction of pavement surfaces; employment of emulsions; application of seal coats; improvements in design and manufacture.

BRICK. Details of Brick Pavement Construction, H. G. Sours. *Am. City*, vol. 46, no. 5, May 1932, pp. 86–91. Review of modern American practice; bedding course or cushion; brick course; types of fillers; applying filler; relaying, replacement, and resurfacing. Before Eighteenth Annual Road School at Purdue University.

CONCRETE. Some Developments in Portland Cement Concrete Road Construction, R. B. Hinder. *Inst. Engrs. Australia—Journal*, vol. 4, no. 3, Mar. 1932, pp. 77–91. Features and merits of cement penetration, or grouting system of road construction which will provide relatively cheap roads of high class, using Australian-made material; test results, costs, and practical construction information; specifications for construction of reinforced-concrete pavements by two grouting systems.

CONSTRUCTION. Road Construction in Ottawa District, A. K. Hay. *Contract Rec.*, vol. 46, no. 18, May 4, 1932, pp. 471–474. Review of progress; cost data on construction and maintenance of bituminous road surfaces; treatment of gravel roads.

CONSTRUCTION COSTS. Where Highway Dollar Goes, J. L. Harrison. *Pub. Roads*, vol. 13, no. 2, Apr. 1932, pp. 21–31 and 38. Study of cost distribution in the construction of concrete pavements; distribution of highway dollar in markets of the nation; freight costs; fuel costs; wage account.

DESIGN. Hyperbola Is Best Street-Crown Curve, M. W. Furr. *Eng. News-Rec.*, vol. 108, no. 18, May 5, 1932, pp. 656 and 657. Computations for applying hyperbolic crown curve to normal street section and to unsymmetrical street sections; coefficients to determine crown-drop.

GRAVEL. Re-Conditioning Stone and Gravel Roads, H. D. Wilford. *Can. Engr.*, vol. 62, no. 17, Apr. 26, 1932, pp. 13 and 14, 60 and 61. Methods employed in reconstructing gravel, water-bound, and traffic-bound roads; drainage of subgrade.

ILLINOIS. Brick-on-Metal Base Fails on Illinois Test Road. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, pp. 694–696. Detailed report by the Illinois division of highways discloses the complete inability of a flexible metal base to hold brick surface on a wet clay-loam subbase.

INDIA. India's Road Problem, H. C. Smith. *Roads and Road Construction*, vol. 10, no. 112, Apr. 1, 1932, pp. 116 and 117. The part roads have played in civilization; low cost roads; the need for a comprehensive study of India's future communications; the administration of roads; the ministry of communications; modern road engineering as science; road finance; road loans.

LOW COST. Construction of Low-Cost Highways, G. E. Stephenson. *Can. Engr.*, vol. 62, no. 17, Apr. 26, 1932, pp. 21 and 22, 53 and 54. Comparison between two roads; cost of bituminous top; time for dragging roads; bituminous treatments; methods of application; application of armour coat; application of retread surface.

MAINTENANCE AND REPAIR. Oil-Processed Road Maintenance, New Mexico, W. C. Davidson. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, pp. 690 and 691. Cost data summarize maintenance activities extending over a 3½-year period and including no road less than six months old; horse-drawn traffic destructive; maintenance processes; seal coating; portable pug-mill mixer used in preparation of oil; patching practice.

MATERIALS. Various Combinations of Asphalt and Gravel for Road and Street Surfacing, B. E. Gray. *Nat. Sand and Gravel Bul.*, vol. 13, no. 4, Apr. 15, 1932, pp. 9–15 (discussion) 16–18

Another Madison Square Garden

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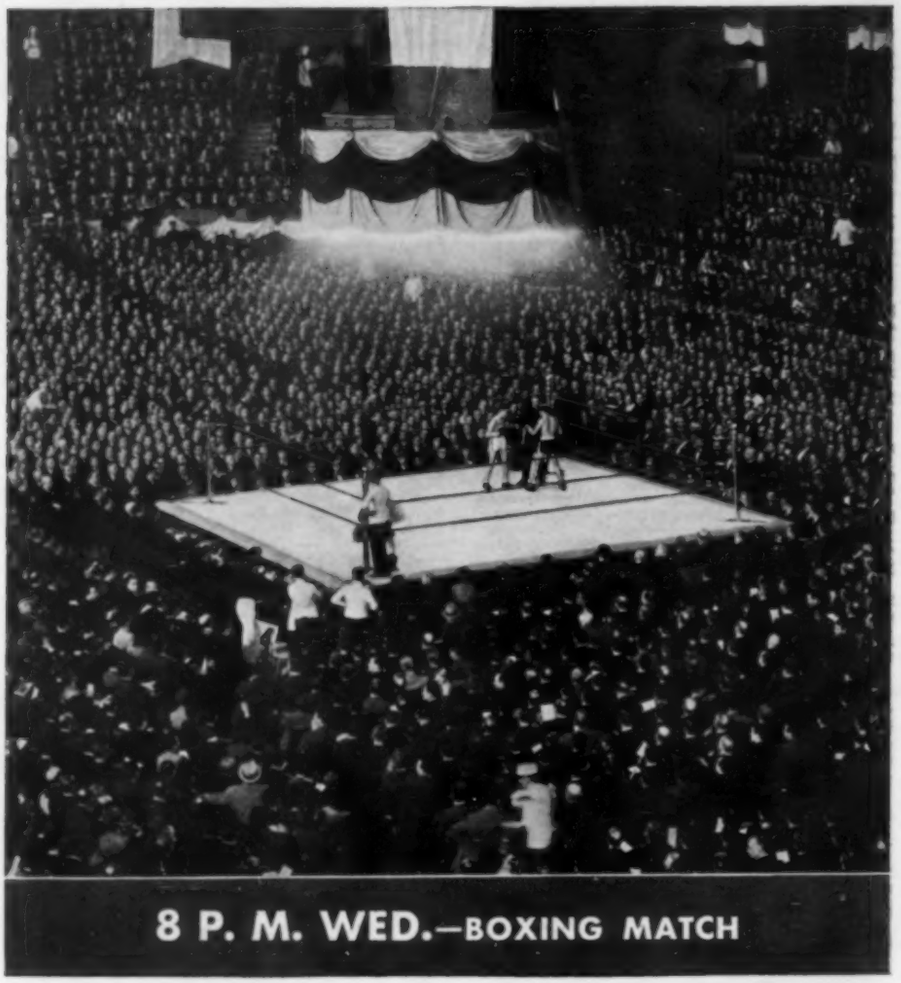

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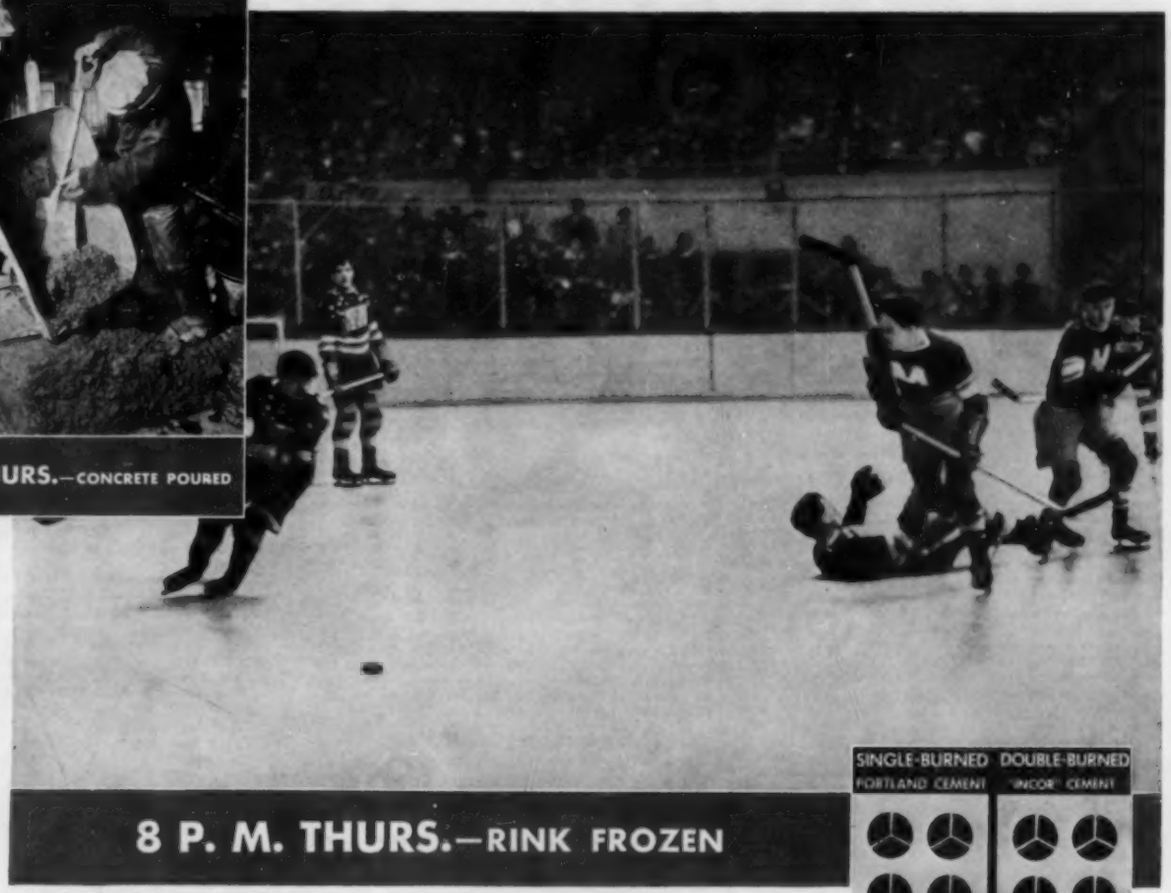

8 P. M. THURS.—RINK FROZEN

road conditions. The first freeze alone, within twelve hours after placing, equals one or two years in the open, say well-known authorities. The 49 cycles of freezing and thawing, completed within the 5 months of the hockey season, equal 10 years of exposure in highways in northern states.

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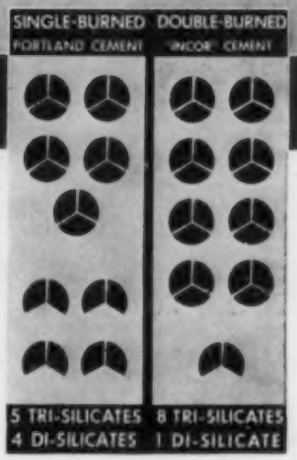

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and 24. Surface treatment of natural soil; gravel surfaces with asphalt treatment; road-mix surfaces; plant-mixes.

RICHMOND, IND. Street Construction and Maintenance Practices in Small Cities, S. W. Hodgin. *Roads and Streets*, vol. 75, no. 5, May 1932, pp. 207 and 208. Practice of Richmond, Ind.; reconstruction of gravel streets; maintenance problems; retreatment practice; resurfacing with hot mix and rock asphalt; laying bituminous top; resurfacing with rock asphalt; securing non-skid surface. Before Purdue Road School.

SIDEWALKS. Construction of Sidewalks in Extension of U.S. Capitol Grounds, L. F. Dieterich. *Am. Concrete Inst.—Journal*, vol. 3, no. 9, May 1932, pp. 627–631, and (discussion) 631. Method of construction of surface treated, exposed aggregate sidewalks built in U.S. Capitol grounds, covering approximately 17,550 sq. yd.; use of wire brushes to expose aggregates.

WYOMING. Wyoming Low-Cost Road Types, Z. E. Sevison. *Roads and Streets*, vol. 75, no. 5, May 1932, pp. 193–195. Practice of laying road surfaces by road-mix, plant-mix, and penetration methods.

SEWERAGE AND SEWAGE DISPOSAL

AERATION. Activated-Sludge Plant with Brush Aeration, G. M. Ridenour and I. G. Lacy. *Sewage Works Journal*, vol. 4, no. 2, Mar. 1932, pp. 263–274. Design, mechanical features, and partial operating results of activated-sludge plant, following scheme of Kessener on weaker sewages and with detention periods more comparable to those used for other types of aeration in the United States; power consumption and surface velocities; sewage flows; raw sewage analysis; general plant results.

CANADA. Sewage Treatment Plant at London, Ont., W. M. Veitch. *Can. Engr.*, vol. 62, no. 18, May 3, 1932, pp. 11–16, 48, 50, 52, and 54. Description of new activated sludge plant which will treat 5,000,000 gallons of sewage per day; sewage flow diagram; aeration tanks; inlet sewers; grit chambers; coarse bar screen; fine screens; main air and drainage piping; air compressors; settling tanks; screening press; plant outlet; operation of plant.

CHLORINATION. Chlorination of Sewage for Oxygen Demand Reduction, L. H. Enslow. *Sewage Works Journal*, vol. 4, no. 2, Mar. 1932, pp. 252–256 (discussion) 257–262. Amount of oxygen demand reduction; practical aspects of chlorination for oxygen demand reduction; cost estimates.

INFILTRATION. Infiltration Into Sewers in Los Angeles, H. P. Cortelyou. *Eng. News-Rec.*, vol. 108, no. 20, May 19, 1932, p. 741. Records of sewer construction and infiltration of ground water by calendar years, 1927 to 1931.

PUBLIC RELATIONS. Sewage Treatment and Public, L. J. Murphy. *Sewage Works Journal*, vol. 4, no. 2, Mar. 1932, pp. 296–299. Sewage disposal as a utility; making the plant attractive; encourage visitors; direct publicity.

ROME, N.Y. Low-Cost Sewage Plant Made Possible by Building New Interceptor, H. W. Taylor. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, pp. 685 and 686. General design of sewerage system and sewage disposal plant of Rome, N.Y., for a daily capacity of 5,000,000 gal.; new sewer permits discharge of effluent into New York Barge Canal, thereby avoiding the expensive treatment that would be required if discharge into a small stream had been continued; sludge-heating plant.

SLUDGE. Removal of Raw Sludge from Settling Tanks, R. S. Rankin. *Sewage Works Journal*, vol. 4, no. 2, Mar. 1932, p. 275–276. Principles of removal of raw sludge from primary sedimentation tanks in plant with separate-digestion units.

SEWAGE SLUDGE AS FERTILIZER, J. F. Skinner. *Sewage Works Journal*, vol. 4, no. 2, Mar. 1932, pp. 279–282. Practice of the city of Rochester with Imhoff plants; cost data.

STREET CLEANING AND REFUSE DISPOSAL

SNOW REMOVAL, UTAH. Snow Removal on Utah State Highways, E. C. Knowlton. *West. Construction News and Highway Bldr.*, vol. 7, no. 8, Apr. 25, 1932, pp. 211 and 212. State spends from $100,000 to $150,000 annually for all-year communication throughout 2,500 miles of highway; methods of snow removal; use of snow fence; equipment.

STRUCTURAL ENGINEERING

RAILROAD CROSSINGS, STRUCTURES. Grade Separation and New Station at Hamilton for Toronto, Hamilton, and Buffalo Railway. *Can. Ry. and Mar. World*, no. 410, Apr. 1932, pp. 169 and 170. Design and construction details of structure which eliminates railroad-street crossing; plan view illustrating new track layout; operating features.

SURVEYING

AERIAL, MAPS. United States Sectional Airway Maps, R. L. Ross. *Military Engr.*, vol. 24, no. 135, May-June 1932, pp. 273–276. Method of preparing a series of 92 U.S. Sectional Airway Maps, being compiled and printed for the Aeronautics Branch of the Department of Commerce by the U.S. Coast and Geodetic Survey; flight checking of territory; addition of new matter; projection; radio ranges; legibility and references.

MINE. Advancement of Surveying Practice, W. H. Galletley. *Colliery Guardian*, vol. 144, no. 3721, Apr. 22, 1932, pp. 771 and 772. Review of the development of government control of mine surveying in Great Britain. Before Chesterfield Technical College.

MAPPING. Graphic Method Aids Plotting of Hydrographic Locations, H. S. Pond. *Eng. News-Rec.*, vol. 108, no. 20, May 19, 1932, pp. 718–719. Development of plotting charts permits rapid and accurate locating on field sheets in 10 sec. after reading two sextant angles; plotting chart for section of San Francisco Bay.

TRIANGULATION. Geodetic Control of Northern Luzon, E. Roberts. *Military Engr.*, vol. 24, no. 135, May-June 1932, pp. 245–249. Methods used in triangulation of a very wild section in the Philippine Islands comprising some 8,000 sq. miles of tropical forest and swampy bottom lands.

TRAFFIC CONTROL

INTERSECTIONS. Control and Design of Multiple Intersections. *Roads and Streets*, vol. 75, no. 5, May 1932, pp. 201–206. Design and control of multiple intersections where more than two streets cross at a point; use of stop signs; officer control; island designs used in Miami, Fla.; signal light control; re-design of Scott Circle, Washington, D.C.; proposed treatment of Logan Circle, Washington, D.C.; rotary traffic; design of traffic circles. Before Am. Road Bldrs. Ass'n.

JAPAN. Automatic Traffic Control System Is Adopted in Japan, Y. Shimizu. *Far East Rev.*, vol. 28, no. 3, Mar. 1932, pp. 127 and 151. General review of change from hand-operated to automatic signals in larger cities of Japan.

TUNNELS

EQUIPMENT. Economics of Deep-Well Pumping Equipment, E. G. Gordon. *Eng. News-Rec.*, vol. 108, no. 17, Apr. 28, 1932, pp. 620 and 621. Although of low efficiency, air lift has no moving parts below water and can operate in crooked wells; plunger and turbine pumps operate in plumb wells and require more maintenance but give much higher efficiencies than air lift; range of capacities of various types of deep-well pumps; size selection; maintenance costs.

WATER RESOURCES

SASKATCHEWAN. Darmody-Riverhurst Artesian Water Area, Southern Saskatchewan, D. C. Maddox. *Canada Dept. Mines-Geol. Survey—Summary Report, 1931*, part B, no. 2300, 1932, pp. 58B-71B. Report on area along Canadian National Railways; general geology; limits of artesian area; artesian conditions; composition of water; descriptions of wells; general structural conditions; water level; list of wells.

UNDERGROUND. Replenishment of Groundwater, S. W. Lohman. *Coal Min.*, vol. 9, no. 4, Apr. 1932, pp. 62 and 73. Comment on lowering of groundwater level by drought; cooperative study of groundwater resources of Pennsylvania by state and Government geologists.

WATER TREATMENT

CANADA. Water Purification Plant at Ottawa, W. E. MacDonald. *Can. Engr.*, vol. 46, no. 17, Apr. 27, 1932, pp. 439, 442, 443, 445, 447, 449, 451, 453–455. Description of recently completed purification plant of rapid sand type, with a capacity of 35 m.g.d., on Lemieux Island in the center of the Ottawa River; method of operation; theory of floc formation; variable rate and automatic master control; washing rapid sand filters; hydrogen-ion control; sterilization.

COLOMBIA. New Water Works for South American City, G. C. Bunker. *Am. City*, vol. 46, no. 5, May 1932, pp. 75–80. Description of new filtration plant at Cali, Colombia, sufficient to serve a future population of 242,000; settling basins; alum dosage; filtered water aerator of "riffle type."

DESIGN. Research Aids Economy in Filter Plant Design, A. B. Morrill. *Eng. News-Rec.*, vol. 108, no. 17, Apr. 28, 1932, pp. 622–625. Innovations incorporated in the design of Detroit's new filtration plant with daily capacity of 280,000,000 gal.; savings are made by using higher filter rates, 20-in. filter beds, small wash-water tanks, and unbaffled basins; maintenance costs reduced by better filter washing; filter gravel and sand; rate of filtration.

FILTRATION. Improved Mechanical Treatment of Water for Filtration, M. C. Smith. *Water Works and Sewerage*, vol. 79, no. 4, Apr. 1932, pp. 103–106. Results of several years of study at the Richmond, Va., filter plant; rate at which water is passed through sand or filter medium; time floc is kept in suspension; mechanical treatment of floc while in suspension; proper return to incoming treated water of portion of settled floc and turbidity; development of mechanical mixing devices; "flocculators" at inlet end of coagulation basins.

MODERN METHODS. Modern Measures of Efficiency in Water Purification and Sewage Treatment, E. J. Theriault. *Sewage Works Journal*, vol. 4, no. 2, Mar. 1932, pp. 283–287. Laboratory side of problems related to water purification and sewage treatment, with particular reference to measures of efficiency or of performance of such plants. Bibliography.

OPERATION. Keeping Rapid Sand Filter Beds in Good Condition, J. R. Baylis. *Water Works and Sewerage*, vol. 79, no. 4, Apr. 1932, pp. 124–126. Character of water is the cause of most filter bed trouble; breaking up clogged places in sand beds; hard spots should be dug out; most clogging is usually along sidewalls; methods of removing clogged places; sand screens at Water Works of East Chicago, Ind.; use of alkali; surface wash.

Study of Pulaski Reservoir, F. J. Sette. *Va. Polytechnic Inst.—Bul.*, no. 8, vol. 25, no. 5, Mar. 1, 1932, 67 pp. Study of the quality of water stored in Pulaski Reservoir, at Pulaski, Va., having a depth of 50 ft. and impounding a volume of 187,000,000 gal.; temperature changes; dissolved oxygen; carbon dioxide; alkalinity; color and turbidity; odors; biological conditions; diatomaceæ, chlorophyceæ, protozoa, and other organisms; conditions affecting growth of organisms

SHEBOYGAN, WIS. Raw Water from Lake Michigan Filtered and Sterilized at Sheboygan Purification Plant, J. C. Zufelt. *Water Works Eng.*, vol. 85, no. 8, Apr. 20, 1932, pp. 424–426 and 455. Outline of operation of plant; mixing tanks, filter basins; cleaning the filters; aeration; laboratory control.

TASTE AND ODOR REMOVAL. Round Table. *Water Works Eng.*, vol. 85, no. 4, Apr. 1932, pp. 444, 447, 448, 451, 452, and 455. Discussion by water-works superintendents of the methods of powdered activated carbon application; average cost of powdered activated carbon treatment per million gallons; change in amount of alum needed for coagulation.

WATER WORKS ENGINEERING

ARTESIAN WELLS. Flowing Boreholes in Rehoboth, Gibeon, and Bobabis Districts, Southwest Africa, H. F. Frommurze. *Geol. Soc. South Africa—Trans.*, vol. 34, Jan. to Dec. 1931, 1932, pp. 129–149. Geology and water resources of the artesian-well area of Southwest Africa; rainfall data; list of flowing artesian wells—their depth, yield, and pressure.

AUSTRALIA. Recent Practice in Australian Water Supplies, S. McConnel. *Water and Water Eng.*, vol. 34, no. 402, Apr. 20, 1932, pp. 171–174. Pipe joints; filtration; service reservoirs; pumping plants; corrosion of water mains. (Continuation of serial.)

CONCRETE TOWERS. Spokane Builds Artistic Water Tower, A. Lindsay. *West Construction News and Highway Bldr.*, vol. 7, no. 9, May 10, 1932, pp. 252–253. Water tower at Lamont and 33rd sts., 123 ft. high, holding steel water tank 78 ft. in diameter by 35 ft. high; capacity of 1.25 m.g.d.

CUBA. Water Supply of Santiago de Cuba, J. D. Montero. *Military Engr.*, vol. 24, no. 135, May-June 1932, pp. 292–294. History of the water works of Santiago de Cuba and features of several plans for its extension and modernization.

MEMPHIS, TENN. Memphis Improves Its Groundwater Supply, F. G. Cunningham. *Am. City*, vol. 46, no. 5, May 1932, pp. 65–67. Description of wells supplying all the water requirements of the city; characteristics of water; new set of supply works known as Sheahan station; new filter plant.

SACRAMENTO, CALIF. Reducing Water Cost While Improving Quality, H. N. Jenks. *Eng. News-Rec.*, vol. 108, no. 17, Apr. 28, 1932, pp. 626–628. Discussion of the water supply problems of Sacramento, Calif.; filtering of river supply provides water at low consumer-unit cost compared with persistently advocated mountain supply; plant investment and improvements in filtration practice and operation management; summary of laboratory analyses of Sacramento water supply for year 1931.

TANKS, CONSTRUCTION. Tank Roof Floated Into Place. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, pp. 702 and 703. In erecting new 5,000,000-gal. water tank at Buchanan Park, Lancaster, Pa., a steel erector eliminated the need for roof falsework by erecting a dome roof at the bottom of the tank on wood pontoons equally spaced around the circumference and then floating the roof to top position; tank is 100 ft. in diameter and 91 ft. high.

UNITED STATES. A.W.W.A. Program Stresses Safety and Economy. *Eng. News-Rec.*, vol. 108, no. 19, May 12, 1932, pp. 698–701. Report on proceedings of 1932 meeting of American Water Works Association; water works improvements advocated to meet normal requirements and to stimulate business; cross-connections; pollution hazards; pipe-line materials; water works equipment; water revenues; water purification; manganese troubles; aeration; mixing basins; sedimentation.